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Edited at the Massachusetts Institute of Technology

Technology Review

Rough Rock, Arizona—see page 14

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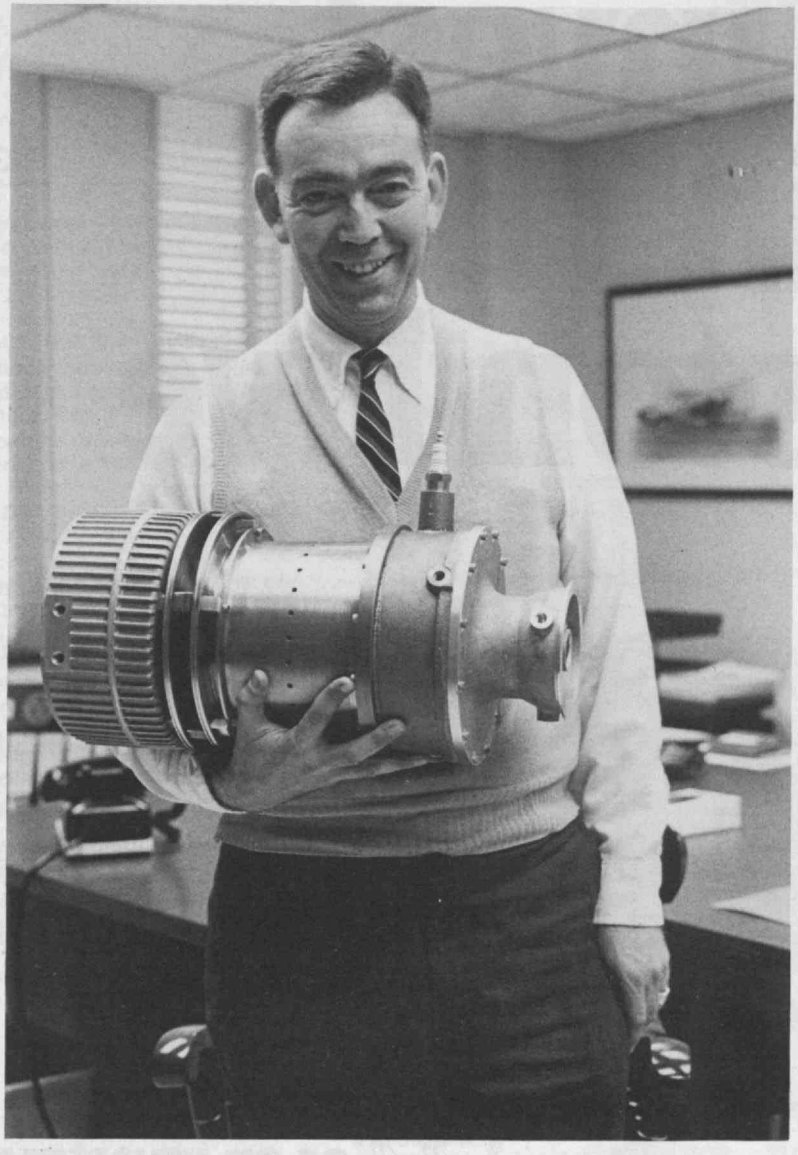

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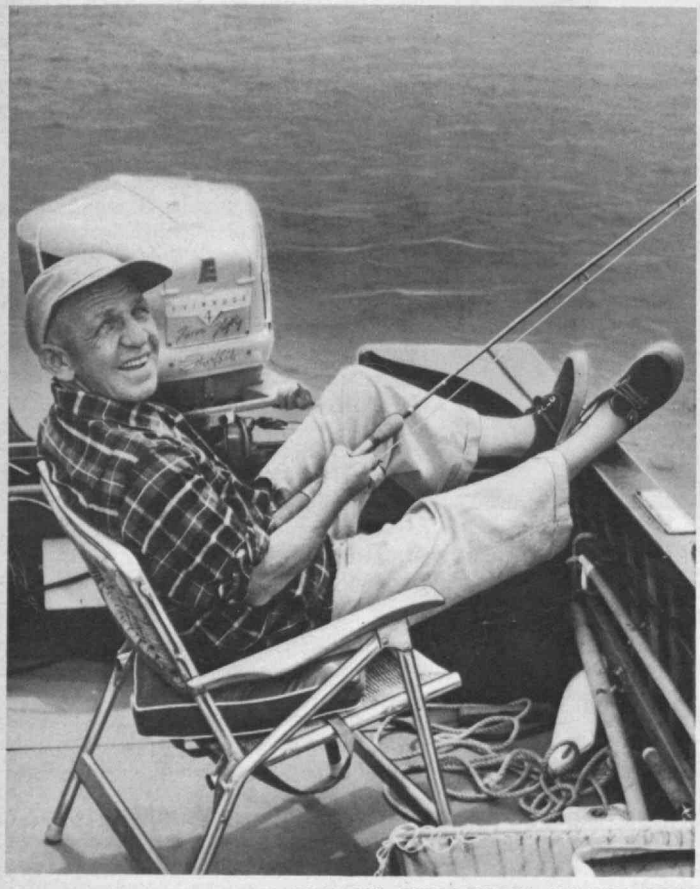

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Technology Review

Edited at the
Massachusetts Institute of Technology
Volume 74, Number 8
July/August, 1972

Articles

Departments

First Line

Volume 74

With this issue, *Technology Review* completes its 74th volume, including eight numbers (combined issues in October/November, March/April, and July/August). Our intention is to prepare an index to the volume promptly, but since indexes remain also to be completed for Volumes 72 and 73 the strength of our resolution may be held in doubt by some. Readers may receive indexes upon request; there is no charge.

Let the Sun Shine In

Clarence P. Thayer, who graduated from M.I.T. in 1923, is a loyal reader of *Technology Review*. He shows his loyalty to his alma mater by each year visiting with high school students in the Miami, Fla., area who are interested in careers for which M.I.T. might be appropriate preparation, and to support his discussion he gives his back issues of the *Review* to students with whom he visits. Hence the photographs, which could hardly fail to bring sunlight into any editor's day.

In October/November

Volume 75 will open with an issue dated October/November, ready late in September. Among the contents:

☐ Nitrogen oxide pollution by Charles N. Satterfield, Professor of Chemical Engineering at M.I.T.

☐ Engineers must understand "software" as well as hardware, writes Gordon S. Brown, Jackson Professor of Engineering at M.I.T.

☐ A chemical concept of pollution and its control by Werner Stumm and Elisabeth Stumm-Zollinger, Swiss Federal Institute for Water Resources.

The Place of Policy

An Editorial

Does the collection of checks, balances, and feedbacks which are together taken as our "economic" and "social" system work so well as to make unnecessary more explicit government intervention through social and technological policy?

The affirmative arguments are strong.

They emerged on two occasions at M.I.T. this spring. At a symposium on the social responsibility of industrial enterprise, it was argued that the competitive free market would in fact alone soon assure that employment opportunities be broadened to include all Americans, that firms fleeing the center city return there, that trade with colonial powers and apartheid nations be restrained—in general, that in today's moral climate public pressure through the economic system will quickly enough favor "good" corporate citizens at the expense of "poor."

Different questions—but with a similar answer—were asked at sessions sponsored at M.I.T. for the National Commission on Materials Policy. Do we need a government-directed program to conserve a scarce resource? No, the supply-and-demand mechanism will serve: as the supply of a material with certain essential properties decreases, the price will rise. Rising price brings with it rising incentive to find a substitute material, or to redesign the technological system to eliminate material first deemed essential.

We need only—so the argument goes—define and understand our options; the choice between them may safely be left to the marketplace in which economic and social issues are weighed. Shall we hasten that deliberately slow process of marketplace decisionmaking on issues which we deem to be urgent? Only at peril. Will in fact public pressure for a cleaner, safer automobile work fast enough? Perhaps. Can we trust the supply-and-demand mechanism to modify our ever-rising demand for energy before we are led to crisis? Probably.

But the Editor is indebted to Gordon S. Brown, Jackson Professor of Engineering at M.I.T., for the ultimate question which rises above technology and economy alike: Is any man, or any nation, entitled to use an irreplaceable resource —petroleum, for example—for his purposes alone, and to consume it with gross inefficiency and largely for purposes which may be deemed nonessential if not indeed frivolous?—*J.M.*

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Letters

Wanted: An Ellsberg for the A.E.C.

In *Technology Review* for December (*p. 6*), Robert C. Cowen records the Atomic Energy Commission's concern that its arguments have "left visceral doubts intact." No wonder. If the A.E.C. would stop playing God, eliminate the secrecy, be honest, keep the public *fully* informed, and—above all—admit its mistakes, the credibility gap would disappear.

The A.E.C. for years made little of radioactive sand tailings used as fill for homes and schools. Following the 1963 limited test ban treaty, which prohibited tests that vented radiation, 16 of at least 200 admitted underground explosions of nuclear devices vented radiation beyond the test site. Following the recent Cannikin nuclear test the A.E.C. declared that only 18 otters had been found killed but admitted that casualties might have been somewhat larger; within a month a biologist working under an A.E.C. grant established that the explosion had killed over 1,000 sea otters. The A.E.C. has licensed the construction of over 100 nuclear power plants which rely on never-tested safety devices to protect against water-cooling failures.

The A.E.C. needs the same treatment which Dr. Ellsberg gave the Pentagon.

Moses Cammer
Larchmont, N.Y.

Concentrating on Success

Although you never seem to have sports reporters writing columns about science, your review of the World Science Fiction Convention (*"Science Fiction: Will Robots Marry?" March/April, pp. 3-9)* seems to have been written by someone who either doesn't know much about science fiction or is not very sympathetic toward its aims and accomplishments.

Your reporter confuses the public speaking styles of Cliff Simak and Isaac Asimov with their depth of understanding and their personal convictions. But his worst mistake is assuming that the predictions made by M.I.T. professors are somehow more accurate or more worthy of attention than those made by science fiction writers.

I think a quick scan at the past 30-odd years of actual history will show that a betting man would have made much more money by listening to the science fiction writers than by listening to the M.I.T. faculty. This is not meant to denigrate M.I.T.'s excellent teachers and researchers. It's merely a consequence of the fact that the workers in any field are very much aware of the difficulties, while generalists such as certain gifted writers can blithely ignore most of the difficulties and concentrate on the eventual successes . . . and their consequences.

One final note: the words *android* and *robot* are no more synonymous than *plastic surgery* and *structural engineering.*

Ben Bova
Editor, *Analog*
New York, N. Y.

Urban No-Growth Strategy?

I disagree with the assumptions implicit in the Susskind-Hack article in *Technology Review* for February (*"New Communities in a National Urban Growth Strategy," pp. 30-42*). Mssrs. Susskind and Hack apparently believe that more urban growth will be good for the country. It is time the myth of "urban growth forever" be seriously examined.

Answers to the problems of central city poverty and decay will not be found in just more growth. By overemphasizing the importance of new construction, urban planners draw attention away from the causes of urban decline. Priorities for growth apparently overlook the fact that the processes of growth and decay are causally connected; more growth will generate more decay. Before this country commits its resources to a new communities program, planners ought fully to explore the probable consequences of encouraging additional urban growth. Several reasons for such caution can be advanced.

☐ The new communities concept ignores the causes of urban decline by pretending that new towns will never become old towns. The process of urban aging is not well understood. No one knows how to prevent new communities from following the same path to decay and stagnation that our older cities have followed. New buildings inevitably become old buildings and thereby alter a city's economic and demographic character. If all of a city's buildings are constructed at approximately the same time, might they not also fall down at about the same time some 50 to 100 years hence? Our present inability to cope with urban

decay is a strong argument against the creation of new communities whose "blight potential" could exceed the scale of anything we know today. The long-term problems created by a massive wave of new community building may be far more serious than the short-term problems they were built to solve.

☐ New communities will also accelerate the decline of existing cities. Present urban areas will obviously suffer if a significant fraction of new economic growth and related public investment are channelled away from them and into a new communities program. Even more serious, however, is the fact that suburban growth contributes to the abandonment of cities. Aged commercial and residential buildings in the city are now being vacated in favor of new construction at the urban periphery. Middle-class families are moving to new housing in the suburbs faster than the inner-city poor fill the housing left behind. As a result inner-city housing is often quickly consumed and abandoned. This can only happen when supply exceeds demand. And as more central-city poor find their way into newer neighborhoods, a fearful middle class increases the demand for new suburban housing. New communities may hasten the decline of the central city by encouraging even more outmigration. It may well be that the faster we build new communities, the faster the old ones will decay. Public policy which subsidizes new urban growth is ill-advised if the result is to hasten the destruction of existing urban centers.

☐ New communities unwittingly postpone the necessity of limiting urban growth. Growth itself is a dynamic process that continues until some counterpressure stops it. As long as there are new places to grow into, there is little pressure to stop growing. New growth provides only temporary relief from the pressures that continuously build to stop growth. By making new urban growth easier, one result of a new communities' policy will be to insure the fact that there will be more people to live in them. And more people will certainly create new pressures. When all of the new towns are filled up, what will happen? Do we then stop growing, or do we build still more new towns? The continued growth of our population and our urban areas is neither possible nor desirable.

I submit that the difficult question concerning new communities is not how to build them, but whether to build them at all. A "national urban growth strategy" that fails to address the *desirability* of urban growth is not a strategy. Urban planners must seriously analyze the long-term results of their actions to understand the future toward which they are working. Only by looking ahead can we rationally decide what to do in the present. Before urban growth and new communities policies are fully institutionalized in a federal bureaucracy, the consequences of urban growth must be understood.

Louis Alfeld
Sloan School of Management
M.I.T.

(Letters continued on page 70)

Delphi Again: The Diverse Responses

Science Review:
Robert C. Cowen
Science Editor
The Christian Science Monitor

The so-called environmental challenge raises basic philosophical, economic, and political issues. This seems to be the main reason M.I.T.'s Jay Forrester and Dennis Meadows have achieved more flak than reasoned discussion by their work in using primitive computer modeling as a tool to predict world development.

In a way, the M.I.T. group and its Club of Rome associates have only themselves to blame. The publicity hoopla with which they released the layman's version of the Meadows study deafened many a potentially receptive ear. But that is no adequate reason for the supercilious kiss-off that many critics, especially economists, have given this immensely important work.

It is beside the point to dismiss it as, for example, economist Allen Kneese (of Resources for the Future) did when he said: "This kind of model has been discussed more or less continuously since Malthus. Either they're ignoring history and the work of their precursors or they're doing a snow job. . ."

Perhaps I make too much of it. But this kind of reaction implies a deep sense of shock. It seems a defensive rejection of a direct challenge to one's fundamental image of man's role in nature, his life prospects on this planet, and to a mystical faith in the inherent goodness of growth. The Forrester-Meadows work does indeed strike hardest at this fundamental level. So to focus criticism on the inescapable limitations of this early computer modeling demeans the discussion.

The World Model

To summarize sketchily what has already been widely reported, Jay Forrester showed in a preliminary way how to simulate world development with a computerized model interrelating the five basic factors of population, farming, natural resources, industrial production, and pollution. He has described this in his book "World Dynamics" and his *Technology Review* article ("Counterintuitive Behavior of Social Systems," January, 1971, pp. 52-68).

Impressed with the potential of such modeling to bring more precision to analysis of man's global fate, and backed by Volkswagen Foundation money, the Club of Rome commissioned a team under Dennis Meadows to improve and expand Dr. Forrester's work. Technically, it demonstrated more fully the potential and limitations of such modeling as an aid to forecasting and planning. Philosophically, it reached much the same conclusion as did Dr. Forrester's preliminary analyses.

However the computer juggled the five interacting factors, mankind would be headed for ecological and economic disaster unless it shifted from a course of population and economic growth to one of equilibrium. Either resource exhaustion, ecological collapse, or some other horror rang down the curtain in all other cases. The end would come on a flexible timescale depending on specific assumptions used for specific simulations. But 70 to 100 years is the size of the ballpark.

Backlash Against Doomsday. . .

As an unofficial organization of leading scholars, businessmen, and government officials, the Club of Rome is a kind of ecological Pugwash. It is just as eager to influence governmental policy as to sharpen mankind's perception of its darkening future. Therefore, it took the route of publicity in announcing the Meadows study, even before detailed reports hit the scholarly literature. As a science reporter, I think this move was bad. It gave the project the flavor of doomsday lobbyist propaganda rather than of concern arising from scholarly work. Worldwide, but especially in Washington, a powerful backlash is building up against this sort of thing. It had needlessly been aroused in some quarters against the thesis of *The Limits to Growth.*

Club of Rome spokesmen such as Aurelio Peccei (a Fiat and Olivetti executive and Club organizer) have defended this tactic by saying they want to reach decision makers whom the scholarly press would pass by. They have succeeded. "Limits" has been almost as topical a theme in governmental circles since its release last March as were President Nixon's visits to China and Russia. But the message getting through may not be what the Club intends.

Prominent figures in developing countries, such as Indian Prime Minister Indira Gandhi have acidly asked how to achieve "equilibrium" equitably in a world where "20 percent of the world's population consumes 80 percent of the natural resources of the globe and produces about 90 percent of the world's wastes and pollution." Will *The Limits to Growth* become simply another club with which self-righteous environmentalists in rich countries can beat the world's poor?, they ask. It could just as easily be used the other way around as Mrs. Gandhi's assistant Ashok Parthasarathi has pointed out. Since *The Limits to Growth* emphasizes the finitude of world resources, it implies that a drastic redistribution of global wealth must be made in order to bring equitable living standards to developing countries, standards which the study shows won't be achieved by traditional economic growth alone. This kind of political squabbling will be just as obstructive of the Club of Rome's mission as the instant dismissals of its critics.

. . . And Sober Regard

Not all the reaction has been quite so emotional. On the policy side, for example, American presidential science advisor Edward E. David, Jr., commissioned two separate studies of the M.I.T. work. He sensibly concluded that the work has shown the potential help such modeling can give in planning. It has reinforced faintly emerging suspicions that there are

indeed limits to traditional growth. But it has not yet provided a reliable guide for actual policy making.

In scholarly circles, some university groups are subjecting the computer models to further study and development. Ray Curnow and colleagues at Britain's University of Sussex have run the M.I.T. models on their computer more than a thousand times. They find that reasonable shifts in assumptions for the basic parameters, such as rate of new mineral discovery, can shift the doomsday epoch by a century or more. As they point out, this demonstrates the limitations of the computer models without invalidating the basic conclusion as to dangers of unbridled growth.

One Book: Two Points

This points up what is perhaps one of the main communications problems the Club of Rome faces. It is trying to get across two rather distinct and important messages on two different levels at once—the technical usefulness of global dynamic modeling and the apocalypse of growth. It's a little like the Delphic Oracle trying to deliver the dictum of the gods and explain the techniques of prophesy at the same time. The two messages get confusingly tangled.

On the technical level, the M.I.T. studies do indeed look promising, although at this stage they tend to demonstrate the limitations of modeling more than their utility. They deserve far more scholarly attention such as the Sussex group is giving them than they have so far received. Indeed, one critic, Martin Shubik of Yale University, makes a valuable suggestion when he urges the Club of Rome, the National Science Foundation, or some other agency to sponsor a conference to evaluate the role of modeling in the social sciences.

This is quite apart from *The Limits to Growth*'s larger message. Whatever the weaknesses of the computer modeling, it aptly points out that earth's material resources are inherently limited. Thus growth that is largely material—of food production, population, resource exploitation—is inherently limited too. And mankind is beginning to run up against the limits *(see "Further Comments: The Limits to Growth," p. 68 of this issue).*

Like Buddha, Jesus, Lao-Tse, and J. S. Mill

Nevertheless, there are spiritual types of growth that, as Dr. Meadows points out, would offer mankind unlimited challenge and opportunity for expansiveness even in a fully equilibrium world. Here the term "spiritual" subsumes the arts, education, and those many other less material aspects of humanity's richly diverse culture. It's interesting that the M.I.T. computerized studies have inspired the same kind of conclusion many of the world's great religions reached long ago. Man's long term destiny lies in spiritual realms far more than in the material. We can keep on growing indefinitely in this way by bringing materialism under sharp control. But purely material growth is the highway to extinction.

Dr. Meadows is quite right in saying that, to accept this in all its social, political, and economic implications, requires a Copernican revolution in human thinking. He then should not expect to get a much better reception than did Copernicus himself. Shocked at this challenge to basic outlooks, many critics do indeed divert attention to the drawbacks of the computer models. It's too bad. But it's inevitable. So too is the turn-off in many people's thinking at the sheer immensity of the psychological challenge. And that challenge will appear in different form to every distinct culture and subculture on earth.

Barbara Ward and René Dubos make this point eloquently in the introduction to their book "Only One Earth," the unofficial background document commissioned for the United Nations Conference on the Human Environment. They too have raised strong doubts about the viability of continued material growth. As they circulated their first draft among a galaxy of experts around the world, they received such a diversity of criticism that they call it an anthology of confusion. But they welcome this as springing from the rich diversity of humanity—a diversity which must be factored into any analysis of world trends or any planning for world ecological salvation.

In most cases, these authors point out, the conflict of views "originate not from uncertainties about scientific facts, but from differences in attitudes toward social values." "But," they add, "far from being a reason to despair, this divergence of views is in fact the expression of one of the most appealing aspects of the human species—its diversity. There are possibilities within the human environment for many different kinds of surroundings and ways of life."

Club of Rome members and supporters of *The Limits to Growth* thesis are justified in deploring the relative lack of serious attention so far paid to this work. However, they must learn to meet the diversity of human thought where that thought is. They should tone down the note of doomsday anguish in their voices. They should remove the flavor of godlike certainty from their prophesies. Then, slowly over the long time scale such a turn around in thinking inevitably takes, they will have a much better prospect of getting their thoroughly disturbing point across.

Standing Firm on Auto Emissions

Washington Report:
Victor Cohn
Science Writer
Washington Post

"Do you think the automobile is here to stay?"

Smart-alecks used to snap out that line in grandpaw's day; the way things are going for the monsters from Detroit, the ancient line, like so many cars, may now be recalled.

And the answer may be, "Who knows?" One thing seems certain: if the automobile is to survive, it will have to be radically changed.

This is one lesson of one of Washington's newest Technological Melodramas —"The Govt. vs. Detroit." On May 12, 1972, ending this spring's performance, Environmental Protection Administrator William D. Ruckelshaus forthrightly denied the auto-makers' request for a one-year reprieve from the requirement that 1975 cars must cut hydrocarbon and carbon monoxide emissions by 90 per cent, compared with 1970 models.

Editorialists promptly praised Mr. Ruckelshaus, and even Ralph Naderites were pleased at this victory over the evil corporations. Pleased but not fooled. Government, corporations and Naderites —and certainly scientists and engineers in on the drama—are keenly aware that the matter has not yet been settled, politically or technologically.

Politically, the drama began with Senator Edmund Muskie's Clean Air Act of 1969, which set the new emission standards. First for dirty hydrocarbons and harmful carbon monoxide; then, with '76 model cars, for oxides of nitrogen, which make the sky yellow-brown.

The automobile manufacturers set to work—sort of—on the clean-up. This industry has not been famous for more than making present systems work a little better, or, in the case of automobile bumpers, ever worse. Development laboratories and engineering staffs were now enlarged, however, and the action got more feverish as the time to freeze designs for the '75 models rapidly approached. It is unlikely that any future historian will hail the effort so far as a Manhattan Project. But effort there was.

Came 1972, however, and the auto firms began crying, "Uncle Sam!" The law said they could have a one-year delay if meeting the standards on time was not technologically feasible, and from Volvo, Chrysler, Volkswagen, American Motors, Ford, G.M., the requests wheeled in.

Mr. Ruckelshaus and aides held public hearings, almost three weeks' worth. The manufacturers brought in their evidence by the boxful. E.P.A. officials wrestled verbally with the automotive vice presidents, as reporters scribbled notes.

It was instant technological assessment. And it soon became clear that the gadget to scrub the exhaust gases—turning the hydrocarbons and CO into harmless CO_2 and water vapor—is the catalytic converter, a bit of platinum-coated magic to do for exhausts what Listerine mouthwash does for your breath.

The Catalyst G.M. Missed

G.M. said it had sent some struggling automobiles around the test tracks with various catalysts, which had done all right up to a point, but not up to a 1975-model point. Nonsense, testified the leading catalyst makers. They had put *their* latest catalysts on test cars on *their* test tracks and they were definitely great.

News to us, said G.M. on April 17, the single most damaging day of the hearings to the automobile cause. For Mr. Ruckelshaus and his colleagues obtained General Motors testimony that:

☐ G.M. had been able to make catalysts of its own and of others' designs run no

more than 5,000 miles without failing. But it had not yet tested a catalyst made by one of its British suppliers that had been successfully used for more than 20,000 miles to that date in a stock-model Chrysler.

□ The company had offered no special financial aid to firms it expected to depend on for catalysts. Of $683 million G.M. had spent or committed on emission controls since 1967, only $22 million or 3 per cent had been spent on catalysts, though, as Ruckelshaus pointed out, "this seems to be the key device." (G.M. had spent $41 million more testing a variety of controls.)

G.M. Vice President for Environmental Activities Ernest M. Starkman testified that the company did not even know of the 20,000-mile catalyst test.

"You'd better go look at that car running around a track someplace in England!" shot out E.P.A. Assistant Deputy Administrator George Allen.

Why hadn't G.M. yet seen this promising catalyst?

"Don't believe we won't try to find out what happened," said Mr. Starkman. "Maybe you'd better hold some hearings," Mr. Allen suggested.

This sort of incident was played and replayed, suggesting that big business can succeed in being just as inefficient as big government.

As if the testimony of the catalyst-makers were not enough to discomfit the industry leader, Ford said that while it could not fully make the '75 standards, it could meet some interim ones that went much of the way. Chrysler said it could do almost as well. Ford also announced a $4.5 million commitment to one catalyst manufacturer to expand plant capacity, with an understanding that this company alone might build the catalysts for 50 per cent of Ford's 1975 output.

The One Firm That Succeeded

Finally, to outdo all the Big Three, came the witnesses for Toyo Kogyo, maker of another of those increasingly ubiquitous Japanese bugs, the Mazda, still little seen in the Eastern U.S. but already big on the West Coast and moving inland.

The Mazda, it seemed, is powered by the German-invented Wankel engine. With the Wankel, said Mazda engineers, prospects seemed "fairly bright" for meeting the 1975 rules. Mazda's cars were still going around its tracks; it would know for sure by fall.

Mr. Ruckelshaus had said that if one manufacturer could meet the standards, all would have to do so.

By the language of the act, he could also rule that effective technology had not been in effect long enough to achieve compliance in time. But he was not eager to do so. Politically, there is no percentage in permitting pollution. On May 12 he ruled that the companies had failed to make a case that "present control technology is not available."

"The Battle Has Barely Begun"

Yet the drama is far from over, politically or technologically.

"Politically," said a knowledgeable staff member of the Senate Public Works Committee, "the Administration now can have it both ways. It has been tough on Detroit. And it has now forced the companies to go to Congress for relief. Then it can blame Congress if relief is granted —or if it isn't and there is automotive unemployment."

Ford has raised the unemployment spectre. It has said Mr. Ruckelshaus should himself take the issue to Congress, because strict adherence to the 1975-76 deadlines probably would force it to shut down. It said a one-year Ford (and Ford supplier) shutdown would create 800,000 unemployed and cut tax receipts by $5 billion.

Faced with such arguments, will Congress yet change its mind? Or will E.P.A. decide to listen once again to requests for delay?

That may depend on the results from the little fleets of cars now going around those test tracks. Technically, it has become plain, the battle for a clean car engine has barely begun.

For one thing, the prospective emission control system is what one federal technical official calls a "kluge [rhymes with rouge] machine," a hodgepodge of devices that all must work.

For another, the controls will add at least $200, more by some estimates, to the price of every car; cause a 3 to 12 per cent increase in fuel use; cause an increase in maintenance costs (the catalyst will have to be replaced, it appears, after about 25,000 miles); and cause a deterioration in driveability.

These estimates come in part from a committee of the National Academy of Sciences (charged by Congress with overseeing the state of auto technology), in part from a White House Office of Science and Technology (O.S.T.) report. Both reports have been attacked as industrially and politically influenced, but there is no indication that either presented anything but the facts (though the O.S.T. report added some doubtful cost-benefit judgments).

The Academy committee also said that, while some of the bigger car-makers might be able to make the '75 deadline, a year's delay would give everyone time to do a better job. This made most environmentalists furious, simply because any loss of momentum threatens the present environmentalist-versus-industry balance.

Accordingly, Senator Thomas F. Eagleton (D-Mo.), conducting clean-air hearings in the absence of a still-campaigning Senator Muskie, flayed the Academy report as the result of "a nice admiration society" between scientists and industry. He denied the spate of "clean air can't be done" reports.

He flayed Ruckelshaus for having "caved-in" to the auto-makers by telling them (as the Academy committee had recommended) that they could merely *sample* 1975 cars as they come off the production line, making sure their *average* emissions are low enough, rather than requiring them to test and certify *every* car as in full compliance.

Testing every car, say E.P.A. and the auto-makers, would take so many hours as to be prohibitive.

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"But what if I have to go through a state test station every year to make sure *my* car complies?" a consumer might ask. "Will the manufacturer pay for a new catalyst if it doesn't?"

This issue and others are far from resolved.

So is the future of the internal combustion engine.

But the cleanest engine imaginable would not refute the fact of the car as pollutant. The automobile problem is not just the air. It is the domination of the land by cars, highways, and parking lots. It is the whole direction of American transportation and the fate of the decaying cities, deserted by the still-automobiling commuters.

Is the automobile here to stay? That question still has not been faced.

Quarrel Over Car Pollution

National Report:
Victor K. McElheny

The draconian U.S. air pollution standards for 1975 and 1976—chiefly affecting the manufacture and use of the automobile—might seem like enough of a revolution for the nation's basic means of transportation to undergo at one time. Actually, further turns of the screw are in prospect.

One major trend is the mandatory inspection of new and old cars to see that their owners keep their antipollution devices working.

New Jersey is instituting annual statewide pollution tests of its more than 3.3 million cars this summer. Adding a minute or two to the mandatory safety inspections at 33 state-run stations, the pollution readings on hydrocarbons and carbon monoxide will become binding a year from now.

California has won from a reluctant Environmental Protection Agency (E.P.A.) the right to begin testing all new cars destined for sale in the state starting January 30, 1973. This is considered an essential preliminary to any program of regular testing of all cars. A trial of this system on 1972 cars (which were certified by the earlier method of extensive tests of prototypes) led to a threat by A. J. Haagen-Smit, Chairman of California's Air Resources Board, to cancel Volkswagen's certification. No fewer than 75 per cent of a test run of Volkswagens had failed the new car test.

A bill has been introduced into the California legislature, with immediate support from the influential *Los Angeles Times,* to begin annual pollution inspections for all cars in Southern California in 1974, and in the whole state in 1977. The cost would be paid by an annual $2 surcharge per car.

California Now Requires Retrofitting

A second major turn of the screw is the retrofitting of pollution controls onto uncontrolled or partially controlled cars. The California Air Resources Board (A.R.B.) has started on both these fronts.

Two devices have been certified for controlling the three major pollutants—hydrocarbons, carbon monoxide, and oxides of nitrogen—from cars of the 1955 through 1965 model years. September 1 is the deadline in the Los Angeles air basin for installing one device, which costs $20, or the other, which costs $55. Both devices work by disconnecting a device known as the vacuum spark advance, which helps control the flow of fuel during acceleration. The deadline for San Francisco is around December 1, and for San Diego is January 1.

California began controlling hydrocarbon and carbon monoxide pollution from car tailpipes on 1966 cars, two years in advance of U.S. controls. Those early controls, in California and nationwide, work at the price of running more air through hotter engines, in the interest of more complete combustion. The result is an increase in output of oxides of nitrogen.

Nitrogen oxides are more significant for eye-stinging photo-chemical smog than is carbon monoxide, whose mass in the tailpipe exhaust of cars is 10 times that of the nitrogen oxides. So, the A.R.B. is moving to put nitrogen oxides controls onto 1966 through 1970 cars. Later models now have NO_x controls.

The A.R.B. only won authority for this step after a bad fight in the California legislature in Sacramento last fall. The bill was killed in committee. There was an immediate outcry, led by the *Los Angeles Times,* and the bill was revived. The A.R.B. has set February, 1974, as the deadline for installing the control devices on some 5 million cars of the 1966 through 1970 vintages.

California is the state which pioneered the regulation of air pollution, both from stationary sources, starting in Los Angeles 25 years ago, and from cars, starting with a law mandating crankcase blowby controls in 1960.

California Worked Hard for Its Hard Laws

It is also in California that regulatory bodies with power over air pollution are under the most intense attack. A Los Angeles grand jury accused an air pollution licensing board, appointed by the same Los Angeles County supervisors who oversee the Air Pollution Control District, of being too generous in granting variances to polluters. The Air Pollution Control District, with Robert Chass as executive director, is under such heavy attack that the Air Resources Board has named a four-man committee of inquiry. Last fall, a committee set up to advise Governor Ronald Reagan and the legislature on pollution recommended that Governor Reagan use his power to declare a state of emergency and immediately ban all gasoline-powered vehicles in the heavily populated, smoggy Los Angeles air basin, and decree an immediate conversion to natural gas or propane fueled cars.

The reply from A. J. Haagen-Smit and his executive director, John Maga, was swift and scornful. Dr. Haagen-Smit, the scientist who worked out the causes of photochemical smog 20 years ago, told the committee members to stick to their knitting. Mr. Maga pointed out that, in three years, California's new-car standards will mandate a pollution level lower than that from gas cars, that the law limits the cost of anti-pollution devices to $85 in California, and besides, the supply of natural gas is limited.

The pressures operating in California were also epitomized by Orange County's passing an ordinance to begin controlling the lead content of gasoline beginning this July 1 and removing all but traces by July 1, 1975. This move was denounced by no less a personage than Russell Train, the lawyer who heads the White House Council on Environmental Quality. He said regulation of such questions by just one of the nation's 3000 counties implied chaos. Bizarrely, the state attorney general Evelle Younger filed a brief in the inevitable suit brought by the petroleum industry, upholding the county's authority. One California judge went along with this argument, but another, ruling later, said the authority rests with the Air Resources Board.

The whole lead-in-gasoline issue may become academic in California when the U.S. Environmental Protection Agency finally decides on a plan for removing lead. The prime reason for taking the lead out is to assure longer lifetimes for the catalytic converters which will be used to scrub oxides of nitrogen from the exhaust—although there is sharp public concern over reports like the one which said lead content in Los Angeles air had gone up 56 per cent in only eight years, to over 3 micrograms per cubic meter, over twice the state health standard. The lead report, incidentally, was withheld for more than a year.

Federal: State—Ideal: Practical

The approach to car pollution in California is drastically different from the one which has been imposed on the E.P.A. by the clean air laws of 1970.

The U.S. approach is steep reductions in all pollutants on new cars in 1975-76, accompanied by drastic limits on the operation of cars in central city areas through federally-approved local air quality plans.

The California approach emphasizes the war on oxides of nitrogen, while easing off a bit on the carbon monoxide and hydrocarbons. Through the programs of retrofitting and tighter new car inspections, California hopes for faster improvements in overall air quality without imposing what it considers hopelessly impractical traffic controls.

Dr. Haagen-Smit made this approach clear in remarks on August 30, 1971, before the ad hoc committee on the cumulative regulatory effects on the cost of automotive transportation (R.E.C.A.T.), headed by Lawrence A. Goldmuntz of the White House Office of Science and Technology.

Dr. Haagen-Smit said: "The most critical air pollution problem in California is photochemical smog, which is formed from reactions between organic compounds and oxides of nitrogen. The public is not going to be satisfied with the pollution control efforts unless the prob-

lem of photochemical smog is solved. Should we not, therefore, stress the control of oxides of nitrogen over controlling carbon monoxide?"

The dispute between California and the Environmental Protection Agency is growing in intensity. The argument is of great importance to the whole country. In contrast to the rather idealistic position imposed on the E.P.A., the California officials talk with the voice of experience about the limits of the possible.

They express worry about the U.S. standards for 1975, which impose an eight-fold reduction from the 1974 level for hydrocarbons and an eleven-fold reduction for carbon monoxide. In 1976, the U.S. plans to impose a seven-fold cut on the oxides of nitrogen exhaust levels. Such drastic reductions in a single year are bound to affect the driveability of the cars. Dr. Haagen-Smit and others want E.P.A. Administrator William Ruckelshaus to grant the one-year extensions of the deadlines allowed in the 1970 laws.

"If the extra year helps get a driveable car, I think that's worth it," says Dr. Haagen-Smit. "I don't want my car to stumble trying to enter a Los Angeles freeway at 70 miles per hour because of the pollution controls. I am not afraid of dying from smog, but I am afraid of dying in an auto accident."

Under pressure from California, which has a special status under the 1970 and predecessor laws, the E.P.A. has granted California the right to set stiffer limits on 1973 and 1974 cars, while withholding judgment on an even stiffer oxides of nitrogen limit for 1975. In 1973, California can set a limit of 3.2 grams per mile of vehicle operation on hydrocarbons, 0.2 grams below the U.S. standard for 1973-74. In 1974, when the U.S. limit for oxides of nitrogen is 3 grams per vehicle mile, the California limit will be 2.

In 1975, California would like to go to 1.5 grams per mile on the nitrogen oxides (with the U.S. limit still at 3) while being less stringent on hydrocarbons, 0.89 grams versus 0.41, and far less severe on carbon monoxide (17 grams versus 3.4). The California officials regard as completely unrealistic the thrust of the 1970 laws toward traffic controls in urban regions. They say this could only be done by providing a less-polluting alternative, some form of mass transit. This could hardly be ready in less than a decade from the time voters passed a huge bond issue—this would have to be billions in Los Angeles—if they passed it. Such a proposal barely passed in the San Francisco Bay area over 10 years ago, in only three of the five counties most affected, and the resulting Bay Area Rapid Transit system is expected to make a one per cent reduction in the vehicle-miles traveled in the region.

The Guard to the Freeways!

The federal clean air laws of 1970 not only mandate drastic reductions in pollution from new cars but also set up overall air quality standards. To meet these, states and cities have had to include, in their E.P.A.-required air quality plans, schemes for drastic limitations on downtown traffic: stiff parking fees and tolls for cars with just one occupant, moratoria on downtown garage construction, total bans on street parking, car free zones, prohibition of truck deliveries during the day, etc.

All this has struck the California officials as ridiculous. They have asked federal officials, only half jokingly, whether they plan to call out the national guard to stop traffic on Los Angeles freeways.

This seemingly dull quarrel between two sets of regulatory bureaucrats is really a fundamental dispute over the place of the car in America's urban future, and over the social and economic prices people are willing to pay for pollution control. Unless the quarrel is resolved in a reasonable way, the result could be a violent counter-reaction to the environmentalist movement. After all, the bonfires of "vanities" (including great works of art) which were lit by the religious enthusiast Savonarola in Florence in the 1490s flickered out swiftly.

Biology and Its Destiny

Special Report
Salvador E. Luria
Sedgwick Professor of Biology, M.I.T.

Fundamental biology is today confronted with a dilemma. On the one hand we are overwhelmed with success. For example, those familiar with the usual balance of enrollment at M.I.T. will be surprised to find that 12 per cent of the upperclassmen at M.I.T. today are majoring in biology. This is a remarkable development—and for the Department a staggering one. Something must be very right in biology.

Yet within biology we have prophets of doom, who propose that biology as a fundamental science has discovered all that is worth discovering, that the rest is trivial. These people are therefore retreating into writing books on philosophy.

This seems to me the same kind of error that somebody would have made writing in 1934 or 1935 that physics was finished because quantum mechanics, which must ultimately explain everything because it is the language of physics, was now known. Therefore there was no point in doing any more experiments, it was only a question of developing this new tool.

What are the facts about biology—biology as a fundamental science and biology as the source of medical and other technologies? We have always known, although most people have not realized it in real terms, that just as physics is the science of the general patterns, biology is the science of the unique patterns. In ascending order, genes are the unique patterns that control the functions of cells, cells are unique patterns of molecular assembly, organs are unique patterns of cellular assembly, and organisms are unique patterns of organ assemblies. The problem of biology—having come of age with the theory of evolution and the discoveries of the 1950s and 1960s—is now to understand what these unique patterns are, how they come into being, and how they function.

Where do we stand in this effort today?

One Cell Twitches; One Spits

All the great achievements which have made some of us feel the same kind of pride in our science that physicists have had ever since Rutherford and Bohr put physics into the modern trend—all these achievements so far result from understanding in one group of organisms, bacteria: what genes are, how they function, and how they are regulated. This is really all that we know, and this is the basis we have to go on. Our problem now is to build on this for the other levels of understanding of which we are still ignorant.

First of all there is the matter of differentiation. Each of us consists of on the order of 10^{13} cells; all the cells have the same genes, more or less. Yet in one sense all of them are different, because even the fact of being located at a different position in space makes them different. If an organ has a shape, we know that the mutual relation of certain cells with their neighbors must be involved in determining that shape.

Therefore, a liver cell which is on the surface of the liver is different from a liver cell which is in the middle of the liver. Now what makes them different? What turns on certain genes of some cells and turns off some others, in order to make one cell a liver cell, another one a muscle cell, another one a nerve cell? Or even what makes one a nerve cell that sends its signals to a muscle in order to tell it to twitch, while another nerve cell sends a signal to a salivary gland telling it to spit?

These are the things we do not know. We suspect that the fundamental problems are similar to those that we have learned to understand in bacteria, but the specific solutions will almost certainly be different because life and evolution are opportunistic, and nothing is done in the same way over and over if there appears to be a better way to do it.

For example, we suspect that hormones work by turning on or off certain genes, but nobody yet has been able to find out exactly how. Today at M.I.T., for example, a great part of the work in the Biology Department is devoted to exactly this problem—to what we call fundamental cell biology, in which the question is how human and animal cells behave, what makes them different in response to external conditions, what makes them different in the course of development, and what can go wrong with that development, making them—for example—become malignant.

Then of course we have the problem of assembly, which is in fact a fantastic thing. We know a lot about protein, nucleic acid, etc., and we know that under some conditions these molecules come together to form cells. Purely on the basis of patterns of weak bonds, the appropriate molecules suddenly form precise

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patterns—the shell of a virus, perhaps —simply coming together spontaneously in a test tube in the presence of proper conditions.

Or a more subtle problem: the question of membranes, in which protein and lipid molecules assemble to form some of the most critical components of cells and of organisms. Membranes, indeed, are the things that control the transport of ions and therefore the things that control nerve impulse propagation and the response of nerve cells and the network of our brain. Membranes therefore hold the key to our own knowledge, the intelligence which is the one new thing which man has introduced into the universe.

The Larger Problems

Still there are larger problems, beyond the shaping of cells and of organs; these are the shaping of the human body, of human populations, and of nature around us. These are big problems, and they are complicated—and extraordinarily important. I for one am convinced that we must solve the problem of arresting population growth within the next 30 years if the earth is to continue to be liveable. The search for a desirable, acceptable, and more effective means of contraception based on hormone research is one of the major tasks before us.

The question of ecology—the preservation of our biological environment—is also very important, but it is a significantly different problem. The difficulty here is not to find out more science but to find out how actually to do some of the things which our existing knowledge of plants and animals tells us need to be done. The problem of the environment is different because it will not be solved by new knowledge from 1,000 biologists and ecologists. It will yield only to new incentives from ten Ralph Naders.

Federal Laboratories and National Policy

Commentary:
J. Ross Macdonald

The President's Task Force on Science Policy in its report of April, 1970, considered the use of federal laboratories for research applied to important national problems and concluded that "the time is ripe for a comprehensive review of the role and future plans of the federal laboratories, with a view towards reaffirming the mission and plans of some, redeploying some in whole or in part, and closing down others, if necessary."

Two years later these issues still have not been adequately addressed. How can federal laboratories better help meet national needs? What can we say about the number of federal laboratories and the quality of their efforts?

Several hundred laboratories are operated by the federal government—some 75 or so of them by the Department of Defense alone. I believe that notwithstanding the excellence of some, there are probably too many of them—too many if for no other reason than that there are too many poor ones. Some have, in part or *in toto*, outgrown their original reasons for being, either because they have successfully completed their missions or because changes in national needs and priorities have outpaced laboratory changes.

Some laboratories have been undermined by the gradual aging of their population, arising from an inadequate infusion of young professionals and a retirement age of 70. In many laboratories establishing the staffing limit by manpower levels alone fails to distinguish between professionals and technicians, resulting in the inefficiency of employing few or no technicians. Federal laboratories need the more rapid turnover of personnel which industrial research and development laboratories experience.

There is also a disproportionately high limit on capital equipment in some federal laboratories with fixed staffing; such rigidity, which prohibits an optimum trade-off between equipment and people, clearly reduces laboratory output and effectiveness.

Some federal laboratories contract a portion of their funds to industry and universities, and in quite a few cases in-house work has been a small proportion of the total work funded. But as federal budgets have recently been tightened, many of these laboratories, rather than shrink both inside and outside activities in proportion to meet reduced budgets, have decreased their outside support disproportionately in an effort to maintain their internal staffing levels. If the original proportion of small inside support and large outside support was best for the country, as I strongly believe, then this shift has been away from the most efficient use of available monies.

My own past experience at a large stand-alone federal science laboratory suggests that, as such an organization matures and grows, a non-negligible portion of it may move toward basic research which is difficult or even impossible to relate to the original mission of the laboratory. This is evidence that the laboratory has partly lost sight of its original mission-related goals, that it is to some extent structuring its work around individual inclinations rather than public needs. Perhaps because of this decoupling, there is frequently little or no pressure on the professionals doing basic work. They may have only internal, private goals as sources of incentive, and they may lack the intellectual stimulation and/or goal orientation which university and industrial laboratory environments frequently provide.

These problems are now becoming recognized, giving hope for their future amelioration. And despite the problems which affect many of them, I believe the federal laboratories are in fact doing a needed job adequately.

But could it not be done better?

Though it is not enough in assessing federal laboratories to consider each one individually, there are important questions which are insufficiently asked, even at the individual level. Is the reason for

which the laboratory was established still viable? Is the main thrust of the laboratory still directed toward this mission? Is the quality of the laboratory commensurate with its function? I doubt that such individual assessments are, even yet, adequately pursued in many of the federal laboratories.

Even if all federal laboratories could answer these questions positively, important problems would still remain. How can available resources best be allocated among all our laboratories to ensure maximum valuable output? Lack of a firm central policy based on laboratory/mission evaluation, and the associated lack of a central source of funds, makes this virtually a rhetorical question. It should not be.

How much undesirable overlap of missions is there among laboratories, especially some of those supported by differing parts of the Department of Defense? Are there even some laboratory missions which tend to undermine others? No person or federal office is seemingly in a strong position to look across all the laboratories, make comparisons, and strengthen the good ones at the expense of poor ones.

New Modes of Management

With the current pressure toward divestiture of mission-oriented federal laboratories from direct university control and/or sponsorship, there appears to be a growing need for new modes of federal laboratory organization and support.

The recent "Fitzhugh" report from President Nixon's Blue Ribbon Defense Panel suggested that the productivity of laboratories operated by the Department of Defense could be increased if they became contractor-operated. This possibility, with the contractor typically being a private industrial firm, needs further careful examination. Industry's powerful profit-seeking incentives might well yield increased laboratory efficiency and faster progress toward stated goals if they could be brought to bear on federal laboratory operation. Such arrangements will not necessarily ensure better accountability in public service, but they are likely to help. In the end, the infinite regress of "who judges the judges?" which arises in all resource allocation problems, must somehow be recognized and resolved.

Appropriate Periods for Research Fruition

Federal laboratories should not generally try to compete with university basic research but should usually aim at solving perceived problems of national scope. Thus, I believe that there should be little or no place in most federal laboratories for completely undirected basic and fundamental research. Only those few laboratories whose specific mission is to advance America's standing in fundamental science should carry on such work.

If we agree that most industrial research and development effort involves work whose results are expected to be applied outside the laboratory in one to three years and most university work involves studies of a five- to 15-year span, then there appears to be a gap which government laboratories are in an ideal position to fill. Some are currently aiming their efforts in this direction, and I believe that special concentration on research which, when successful, will move out of the laboratory in three to six or seven years is a proper emphasis for many federal laboratories.

Priorities for Resource Allocation

Taking a broader view of the federal laboratories, we need to recognize that the resources they use are only a part of the total federal funds for research and development. And it is now urgent that we turn attention to the largest problem, that of how our total research and development effort should best be distributed. For example, is it best for the country that the Atomic Energy Commission continue to spend almost as much (88 per cent in 1971) on physical research, mostly in nuclear and high-energy areas, as the National Science Foundation spends on research of all kinds and in all areas? (I am somewhat heartened by proposed reductions in the ratio of A.E.C. physical research to N.S.F. research, but it promises to be still at least two-thirds in 1973.) Have not our expenditures on high-energy physics—"big science"—increased more rapidly in the past ten years than can be justified by either potential contributions to national needs or by the maintenance of a high level of scientific culture in this country? Can we afford both bread and cake just now? Even if we think we can, should we?

These questions lead to an observation that, perhaps, America's large-scale scientific and technological projects are generally undertaken without hard, objective evidence to justify them. Much of the difficulty associated with these crucial interaction-allocation problems arises from the lack of central policy and authority. Especially in a time of constant or shrinking budgets, such weakness at the center needs to be changed to strength.

Murray L. Weidenbaum, former Assistant Secretary of the Treasury for Economic Affairs, has suggested that major federally-funded research projects should be justified by rigorous cost-benefit analyses rather than simply by faith in their ultimate benefit to mankind. Such analyses are particularly appropriate and needed for applied science and engineering projects—the kind to which most, but not necessarily all, of our national laboratories should be devoted.

If our scientific resources could be more centrally controlled and allocated, and funding choices then based on careful cost-benefit analysis, these resources could clearly aid the country more strongly than they do at present in reaching important and needed national goals. For example, we might decide that it would be desirable to bring the National Aeronautics and Space Administration back down closer to earth (until earth's problems are better under control), reinterpreting the "S" in N.A.S.A. as living space, not outer space. This could involve a progressive shift in N.A.S.A.'s aims toward full concern with controlling and improving the earthly environment, building itself up as the main federal environmental remote monitoring activity. By the end of this transition, N.A.S.A.'s total budget might well be reduced to perhaps $1 billion a year.

Some of the money no longer allocated to N.A.S.A., plus other money no longer employed for direct military aims, might be used by the Department of Health, Education, and Welfare and the National Science Foundation to fund research on ways to make zero population growth both more practical and more palatable. For example, the National Institutes of Health spent only about $17 million in 1970 on population research of all kinds while the Army spent somewhat more on biological warfare research alone. Which kind of population control do we want?

Since an approach to zero population growth will temporarily result in a larger proportion of older people in the population, we also need to increase greatly our research expenditures on gerontology so that old people will stay healthy longer, can maintain their dignity, will be less of a drain on the rest of society, and can contribute directly to society's aims over a longer effective period.

No matter what we may do in working toward zero population growth, the total population of the earth will grow very substantially in the next few decades, and these added people will certainly require more energy, particularly if the standard of living of any significant proportion of them increases. A large federal laboratory dedicated entirely to new energy sources is badly needed. This need can probably be met most effectively by shifting the aims of the Atomic Energy Commission to make it an "energy agency" dealing with the development of all promising types of energy sources, from solar energy to fusion power.

Much more effort should be directed immediately to social problems involving the interaction of people. To accomplish this, we need more research in social and behavioral areas, and Alvin M. Weinberg of Oak Ridge National Laboratory has suggested the creation of national socio-technological institutes to apply scientific methods to interdisciplinary socio-technological problems.

We should recognize that the frontier, the challenge of our times, has moved from the outer space of the external world to the vastly more complex inner space of men's minds and their interaction. Our present federal scientific establishment is ill prepared to meet this challenge, and here lies the argument for a system of national laboratories better organized to help meet pressing national and worldwide needs, especially the greatest need of all: people who understand their own natures well enough to control themselves and their technological tools, moderate self-interest, fight irrationality, and set human goals above all else.

Dr. Macdonald, who graduated from M.I.T. with the Class of 1944, is a vice president of a leading electronics manufacturer; he is here expressing his personal views and not those of his company.

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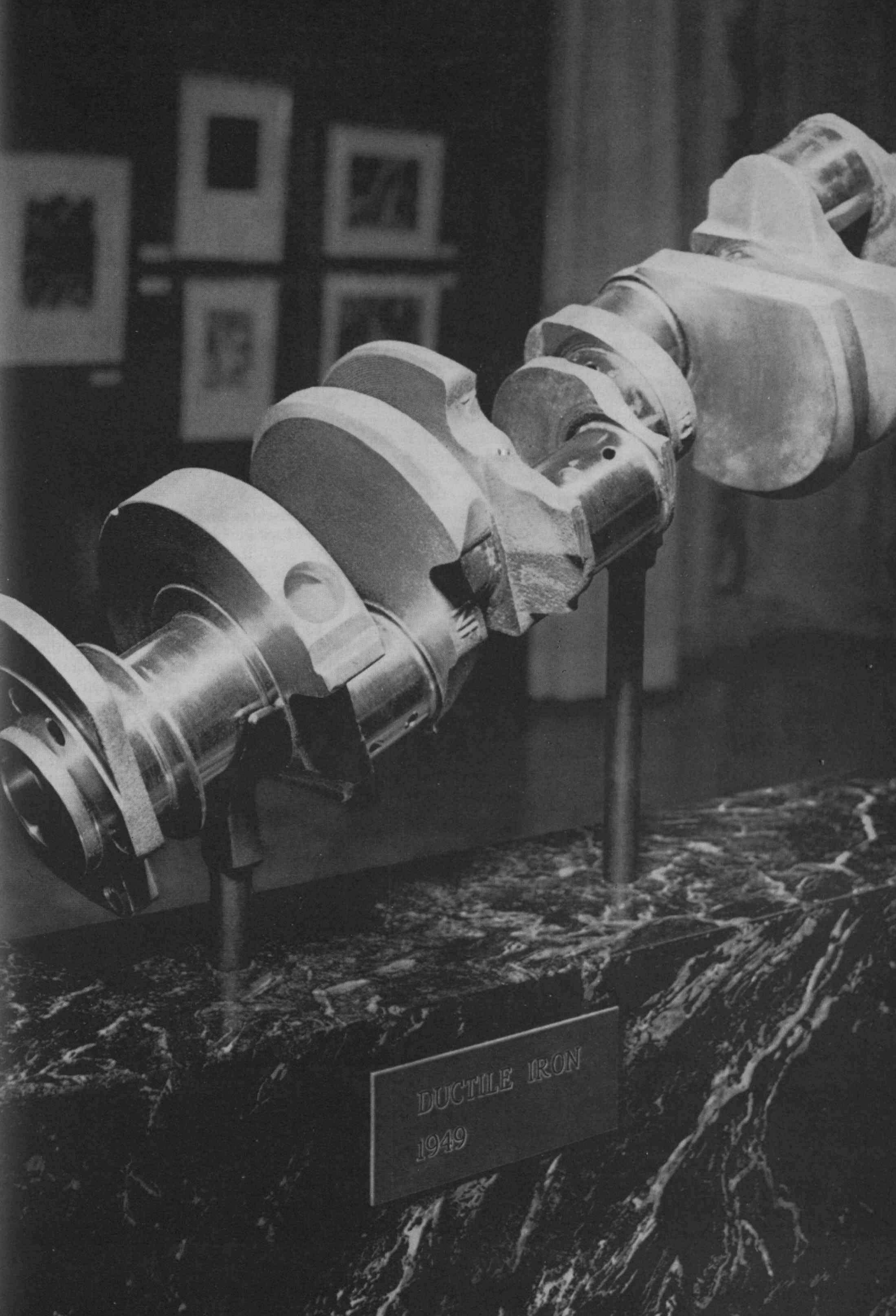
DUCTILE IRON
1949

Chester L. Sprague
Associate Professor of
Architecture
M.I.T.

American Indian Communities: Toward a Unity of Life and Environment

Since 1960 I have studied, in one form or another, American Indian culture, history, settlement structures, housing, health, education, community development. I have been involved in several advocacy roles—chiefly with a housing project on the Blackfeet Indian Reservation and the planning and design of a school with a Navajo Indian community. During this time I have visited some 70 Indian communities, often in the most isolated parts of the country, the places where the Indian people live: the deserts of the Southwest, the Florida swamps, the Alaskan tundra, the Great Plains.

In America there are about 700,000 Indians. They live in each of the 50 states—450,000 on reservations, land held for them by the federal government, and 250,000 off reservations, most of these in small enclaves in large cities. The numerous tribal groups use some 300 separate native languages. Each tribe has its own history, aboriginal culture, degree of Americanization, condition of social health. But they share one thing: the federal government's policy toward Indians and the operational reality of the federal bureaucracy.

For more than a century the federal government has attempted to force detribalization and assimilation on American Indians and to this end has imposed upon them social, educational, health, economic, and land tenure programs designed in Washington and administered at the local level by federal bureaucrats. The government spends $500 million each year on Indian Services, yet the people still live with poverty and its consequences. But because federal policy is not firmly rooted in the needs or desires of the Indians themselves it has created among Indians bitterness towards other Americans, deep distrust of our institutions and laws, racial fear, and corrosive devaluation of their own self-image—but also a stubborn determination to endure.

During my work with Indians, I have formed the opinion, confirmed by others, that only through self-determination can the Indian peoples hope to survive and prosper. Real progress for Indian communities will take place only when the people themselves gain control over the social processes in their lives. When they do, the present fragmented federal approach to community services and planning will be replaced by a more comprehensive one growing out of the wisdom of the communities. Indian self-determination and self-planning will create the best, most efficient, most enduring improvements in the Indian physical environment.

In 1959, when my wife—Joan Sprague, who is also an architect—and I first contacted Indian people, we met them as architects trained in the usual way—interested in so-called timeless beauty and the good life as it was then taught in good architecture schools.

We first became interested in the Pueblo Indians, the Indians of the pueblos of the American Southwest. As we studied the history of the physical pueblos, we became concerned about Indian life and gradually came to see that understanding superficial visual forms is not enough; one must try very hard, with sincere effort, to understand the tribal ethos of each group.

I outline in the first part of this paper the character of our pueblo study to demonstrate the importance of this kind of understanding.

I.
Pueblos: An Historical Study

Taos Pueblo was the first pueblo we saw. It is an impressive repetitive buildup of cubical shapes revealed by bright sunshine and deep shadows, a strong formal image. But beyond this initial impact, which was quite empty of meaning, there was a strong and strange profundity about Taos. The earthen plaza, walls, and roofs and the systematics by which these come together give the impression that the very earth had long ago agreed to arrange itself into patterns of space and light that would be a good home for the pueblo people and their institutions.

We next saw Acoma Pueblo. It sits spectacularly atop a vertical pedestal of rock thrusting from the center of a dry plain. Acoma has elements similar to all the pueblos—but with qualities heightened, exaggerated, taken to their limits. All pueblos feel withdrawn, but at Acoma the vertical cliffs lift it away from its surroundings. Other pueblos are composed of roughly linear clusters of houses, but Acoma's linearity is relentless: straight streets run out to cliff edges where space drops, disappears, to reappear at the distant horizon. Looking out along the streets, Acoma has no setting, no backdrop; it floats above the landscape. Thus, Acoma is intellectual, somewhat Platonic, mathematical.

The space of other pueblos seems softened, and complicated, and

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When the lives of American Indians were their own to fulfill, they achieved remarkable symbioses of environment and culture. Can today's Indians, hampered by years of exploitation, move into similarly effective ties with modern life on the one hand and with their lands and traditions on the other?

The average Indian income is 75 per cent of the national average.

The average Indian age at death is 44 years; for all other Americans, 65.

Some Indian schools have a 100 per cent drop-out rate.

Well under 5 per cent of Indian children in elementary school have Indian teachers.

Indian children, more than any other minority group, believe themselves to be "inferior people."

Indian children are snatched from their homes and sent hundreds of miles away to compulsory boarding schools, remote and alien institutions.

One-third of the Navajo tribe speaks no English at all.

In some areas, without boarding schools, students must walk two miles to the bus each day and then ride 50 miles to school.

Perhaps a majority of all Indian families carry water one mile or more to their houses.

Some 20 per cent of Indian families have no houses of their own; some live in packing cases and abandoned cars.

In some tribes *every* man between 18 and 30 has a drinking problem. In some Indian communities arrests for disorderly conduct or drunkenness every year reach numbers equal to 50 per cent of the population; among certain communities juvenile arrests are almost as numerous as the entire juvenile population.

humanized by a long series of adjustments and accommodations to events and to sites. But not at disciplined Acoma. At Acoma, one perceives the difficulty, the austere dignity of life there, the rough eloquence, the apparent absence of romance and of delicacy in the strong—though bleak and slightly sad—village image in the hot desert sun. Yet Acoma, like Taos, exudes a sense of its own adequacy as a home for pueblo man.

To try to understand how a pueblo is in fact such an appropriate structure for those who build and occupy it, we began to collect plans such as we could find of ruined villages and occupied pueblos, hundreds of them. The study soon moved to a more demanding examination of the social, religious, political, and economic patterns that underly the material, man-constructed patterns of the physical pueblos. We tried to understand American Indian pueblos as physical environments for distinctive groups of people, to understand why these villages are the way they are, what the physical forms represent, how they began and developed, and what is happening to them today.

Our study included an examination of the general physical setting, the climate and terrain that profoundly affected the aboriginal pueblo economy, religion, social forms, and buildings. We studied the interplay between old pueblo culture and building forms and, in this context, the history of the pueblo peoples according to their legends and myths and according to archaeological evidence. The evolution of the physical form of the villages, the component parts, their utility and symbolism were examined, and the geometry of village structure and growth patterns was included.

It was during their search for gold that the Spaniards first encountered the pueblo peoples. Expecting the Zuni villages to be the legendary Golden Cities of Cibola, Coronado found them to be small farming villages built from the brown earth. The town-building farmers and their ancestors had lived in the Southwest for far more than 1,000 years before Coronado. They had developed architectural and town forms from beginnings in scattered pit houses into compact multi-storied fortress villages. Many hundreds of their settlements had been built, but about 90 villages were actually still inhabited in 1540. These the Spaniards called "pueblos," the Spanish word for town, and the people came to be known as Pueblo Indians to contrast them with other Indians, the nomadic camp-dwellers.

Now just under 30 pueblos remain in three general areas: along or near the Rio Grande in north central New Mexico; scattered westward from the Rio Grande into northwestern New Nexico; and in northeastern Arizona, where the Hopi pueblos stand.

A World of Integrating Experiences

Climate, terrain, native culture, and building in the Southwest are dominated by aridity. Despite forested mountains and thinly wooded valleys of a few permanent streams, the commanding aspect is the majestic scale of an immense timberless, water-scarce region. For

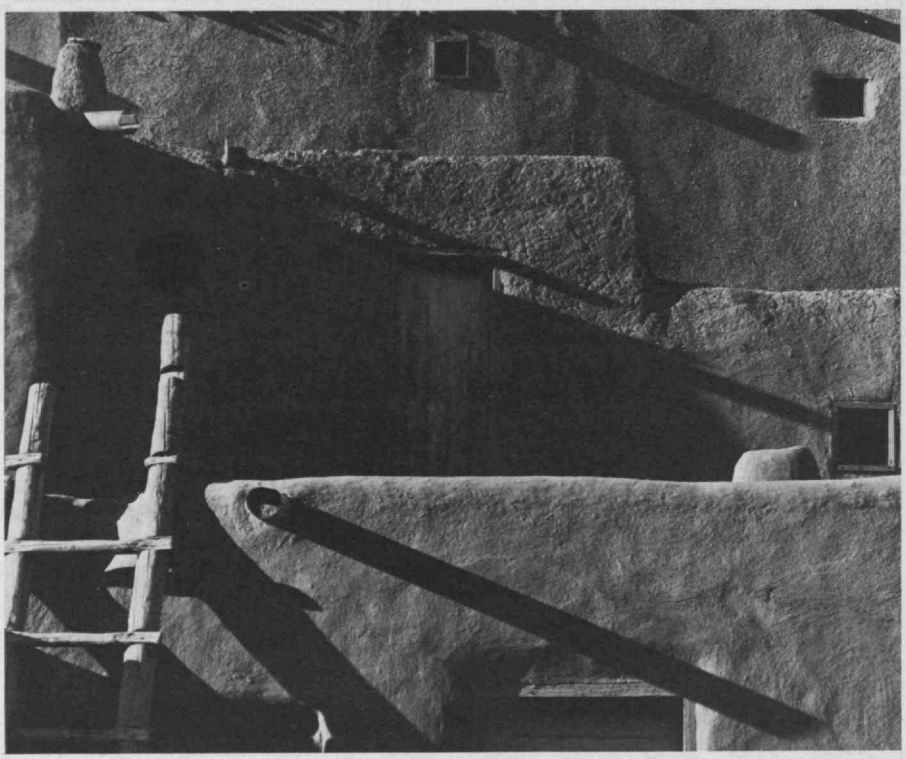
the earlier pueblo people farming was a hazardous venture. And understandably, their history, their social forms, their rituals, and their architecture and town patterns are all deeply interwoven with the needs and anxieties of agriculture in an arid land.

The pueblo ancestors developed remarkably elaborate cycles of religious rites to marshall the aid of cosmic forces and to organize and intensify their own energy to control the hazards of their habitat. By constant, thoughtful adaptation to local conditions, by keen concentration on the demands of their environment, the people learned to prevail through their centuries of life here.

The pueblo religion explained the relatedness of things in the world, both seen and unseen, and provided the means to assure that these forces are induced to work for the people's benefit. They have traditionally acted upon the belief that all objects and events and all essences deeply affect mankind. These all, with man, exist within a cosmic system of mutual harmony, exchange, and interdependence. Pueblo man's responsibilities within this system—what he did to maintain its operation—was to behave properly, to enact the rituals, to reciprocate as a functioning organ of the universal system.

The myths that set out the pueblo people's religions are largely legends of migration—starting from the lowest depth of the lowest world, emerging upwards to this world, and traveling from place to place, experience to experience. Their creation myth is an example—and one that strongly influenced their architecture: "In the beginning all men lived together in the lowest depths, in a region of darkness and moisture, their bodies misshaped and horrible; and they suffered great misery, moaning and bewailing continually. Through the intervention of the god of the interior and the genius of water, the 'old men' obtained seed from which sprang a magic growth of cane. It penetrated through a crevice in the roof overhead and mankind climbed to a higher plane. A dim light appeared in this second stage and vegetation was produced. Another magic growth of cane afforded the means of rising to a still higher plane on which the light was brighter; vegetation was reproduced and the animals created. The final ascent to this present or fourth plane was effected by a similar magic growth led by mythical twins. . . . The twins sang as they pulled the people out, and when the song was ended no more were allowed to come. . . . But the outlet through which mankind came has never been closed, and the god of the interior sends through it the germs of all living things . . ." (Stephens, *Hopi Journal*).

In practice pueblo religious rites were and are a kind of collective willing, an intense striving for harmony and strength. Concentration and group action for the good of all,



A pueblo is a powerful shaper of community life and a uniquely appropriate response to the environment and character of that life. Its tiered levels opening onto plazas suggest the interdependence of all who lived there, and its sturdy form and utility—doors to the sun, walls to the wind—respond to the harshness of Southwestern desert environment. (Photo: Taos Pueblo, by Chester L. Sprague)

American Indian cultures often display a wholeness of life with environment which many other American places and people simply do not enjoy: society and structure become one. Can this unity be captured in the modern world—for Indians, and ultimately for other Americans?

Around the ancient, aboriginal pueblos radiated a concentric spatial order: farthest away, a region of vague information and myth; within the range of vision a circle of mountains, known but unfamiliar; then fields and summer farming shelters; and finally the structure itself, the focus of a self-sufficient community life. (Photo: Oraibi Pueblo, from the American Museum of Natural History)

rather than ambitious personal advancement, have been pueblo norms.

The cooperative, selfless person was a natural integrant to life in crowded villages founded on the ideal of universal mutuality and harmony, an ideal fostered and safeguarded by the dense pattern of pueblo space. The architecture of the villages placed the people at each other's disposal for help in achieving this harmony and its attendant prosperity. But also the pueblos were fortresses, defenses against marauding Indian neighbors. War—not on a large organized scale, but vicious raiding and killing —forced a defensive compactness and withdrawal.

Thus the constellation of social forces forming pueblo collectivity materialized in a unique townscape. In general, two interweaving aspects constituted this townscape: space focused on individual, family life; space focused on public life and its institutions. Within a pueblo these were exemplified by two basic spatial components: domestic rooms with associated exterior spaces; and socio-religious chambers, the kivas, with associated exterior spaces. The interlocking of the exterior aspects of these forms was a third pueblo space component, the plaza or plazas. These three—domestic rooms, kivas, and plazas—were for 1000 years the primary spatial ingredients of any pueblo. In addition, still other complementary components have existed and still are found: stock corrals and related shelters bordered most villages; and there is usually a beautiful old church. Stores and schools have been built in recent decades, and now new houses and housing projects spread out from the ancient pueblo centers.

Pueblo Form and Function

Considerable technological advancement was necessary before the peoples' primitive ancestors could fashion from their lives and environment this three-part core of rooms, kivas, and plazas. The primitive beginnings are identified by archaeologists as the storage pits built by the earliest Southwestern farmers in the floors of natural caves, around the beginning of the Christian era. These farmers did not yet build shelters for themselves; the pits held the harvests of early, rudimentary agriculture. In time, tied to one locale by the demands of a developing agriculture, these farmers began to provide for their own shelter as well. The storage pits became the models for their first shelters—pithouses, single spatial units dug into the earth, surfaced with plaster or stone and topped with a wooden superstructure supporting a thick mud covering. From the birth of Christ till about the eighth century pithouse villages were built all over the Southwest, wherever a spot of arable land could be found.

But in the eighth century the forms began to change; gradually the pithouses evolved into the kiva, the religious chamber for the preparation

and enactment of rituals and the headquarters of the men of a family, clan, or religious order. Also, new domestic space was built on the surface of the ground behind the kiva. Thus, by the ninth century the proto-pueblo form had been created—a front-facing line of domestic rooms with a kiva underground and the trash pile beyond—doors to the sun, back walls to the wind, trash downwind.

The domestic work was done in front of the rooms and the kiva dances were performed near the kiva; thus began the formation of pueblo plazas. In time the row of rooms expanded, becoming longer, wider, and higher. Roof terraces sometimes formed overhead streets, and occasionally these streets were covered. This was the classic pueblo form—compact terraced house rows defining plazas with kivas built into the plazas or into the blocks of houses.

Throughout the Southwest after the crystallization of the pueblo form and until (and in many places continuing through) the rapid Americanization of the 20th century, the typical domestic rooms have been of three functional types—general living rooms, special storage rooms, and rooms reserved solely for food preparation. The living rooms were the principal rooms, the places for most family activities—sleeping, eating, cooking, domestic work, etc. Storage rooms held large supplies of food and family valuables, ritualistic paraphernalia, costumes, and fetishes. Each house had at least one living room and one storage room, often located behind the living space. Food preparation rooms, probably shared by a number of related families, were rarer. When the pueblo grain was ground by hand within the village, there were special rooms exclusively for this purpose.

All old domestic rooms were similar: heavy walls of masonry and thick roofs of wood logs and smaller wood poles covered with adobe formed simple, rude volumes, rectangular in plan and in section. In the old pueblos a smokehole or hatchway was directly above a small central firepit; the draft for the fire came through the door or through a small wallhole near floor level. Spaces were connected horizontally and vertically. The inhabitants entered through the ceiling hatchway or through small doors closed by animal skins, woven matting, or flat stones, and later by wooden doors; door sills were often raised, openings were minimal. The very earliest villages occasionally had ground floor entrances, but later, as pueblos became more defensive, these vulnerable entrances were eliminated. In time all ground-floor rooms were entered through their ceiling hatches from second-floor rooms or roof terraces above.

The kivas were generally not places of public worship—kiva rites remain secret, mysterious, magical, involving the few who perform for the good of all. Kivas have had various forms and locations, originally below ground, now often at ground level though still entered from above. The kiva space was simple, from 10 to 30 ft. in dimension, perhaps a maximum of 10 ft. high. The space was lighted by the sun streaming through the roof entrance or by the fire. Massive masonry walls were smoothly plastered—the floor is of earth or stone. Heavy beams supported the flat roof.

This sturdy, austere room symbolized the place and act of genesis of the pueblo people, their dependence upon the sustaining power of the earth and the position of the earth in the celestial pattern. Many kivas contained a small hole—*sipapu*—in the floor; it represented the beginning of life deep within the underworld, the entrance through which man came to the earth.

Among the Hopi the spatial organization of the whole kiva recalled the four levels of their creation story. The *sipapu* itself was the lowest level under the earth; the main or lower floor represented the second world; the elevated end of the kiva or the bench around it represented the third world where animals originated; and the outer air was, of course, the fourth world, the one now occupied.

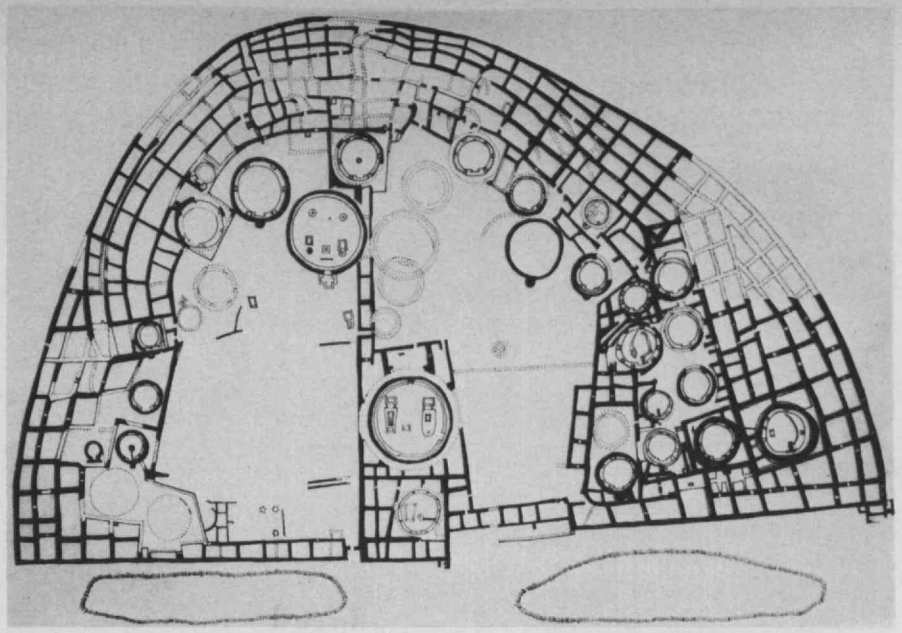
When men descended into the kiva, they returned to Mother Earth, to the source of the generative harmony that supported their lives, in a way to relive their own mythic history so as to reorient themselves to their true purpose here on earth. Often they emerged from the kivas to dance in the public plazas—the highest function of the plazas was to contain these dances.

These dance plazas formed the environmental centroids of the town plans in all old pueblos. The focal role in the town space resulted entirely from the importance of religious ritual in pueblo life; plazas had little or no commercial, industrial, or casual social functions which would draw the villagers to them during the day. Indeed, it was not the custom of the people to collect in large numbers during idle hours for informal socializing—to relax, to promenade, to see and be seen. It was during the public ceremonies that the focal power of the plazas was noticeable: the entire space of the village was seized by the intensity of events there.

Village Plan and Cosmic Plan

Until Western education and wars took many young people far from home, the outer limits of the spatial order of the pueblo world was a region of hearsay, vague information, and myth, passed from generation to generation in vivid legends of all-explaining scope. Inside this most distant circle of the mythically explained lay the circle of the known but relatively unfamiliar: the mountains distant from the pueblo where the gods live, mountains that bounded the visible world seen from every pueblo. Still closer were the fields scattered around the pueblo; with these were grouped the ditches, reservoirs, shrines, observation points, and summer farming houses, all of which formed the outermost built evidence of the pueblo community pattern. Between this agricultural ring and the outer edge of the village itself was a ring of refuse and burial—the remains from the intensive human usage of the pueblo center—and the corrals for animals.

In times of strong defensive need, a blank wall—with but a few small ventilating openings—was the outer limit of the human village. Within this, facing the plazas—defining them, crowding closely in on them, protecting them—were the grandstand rings and rows of the stepped back terraces of domestic rooms. And then the heart of it all, the plazas, the places where the events of aboriginal domestic life move outward and where kiva life moves upward to merge the routines of daily existence with the outline and thrust of cosmic patterns into one conception—the pueblo. Thus in the plazas were intimately joined an inward-moving theme—a kind of ethical directive to daily life, the ever-



The pueblo—tiers of rooms facing plazas below which are the religious kiva spaces—is a giant device for communicating. The plazas are at the heart of it all—the places where the events of surrounding domestic life move and where the kiva life moves upward; thus the routines of daily existence merge with the cosmic questions of origin and place. (Left, the plan of Pueblo Bonito; right, a Hopi pueblo circa. 1900; photo: Smithsonian Institution)

tightening knot of social interdependency—with the upward-rising theme of human history.

Thus the pueblo form fixes the lives of the people, both in time and space. With the placement of the town at the center, the universe was crystallized into the pueblo pattern. The village form tied the minutiae of daily life to the immensity of the cosmos.

A pueblo was a giant device for communicating, an intelligence mechanism providing the pueblo person with a succession of parcels of information which he needed to go about his day, his season, his year, his life; and it gave him a sense of the significance of what he was going about. Pueblo forms reflected not merely "objective" reality or "material needs"; just as important, they reflected the forms of human thought about reality and needs. What the mind had once created, what had been culled from the total sphere of consciousness, did not quickly fade away again once the pueblo had set its seal upon it and given it definite form.

Pueblo as Social Conditioner

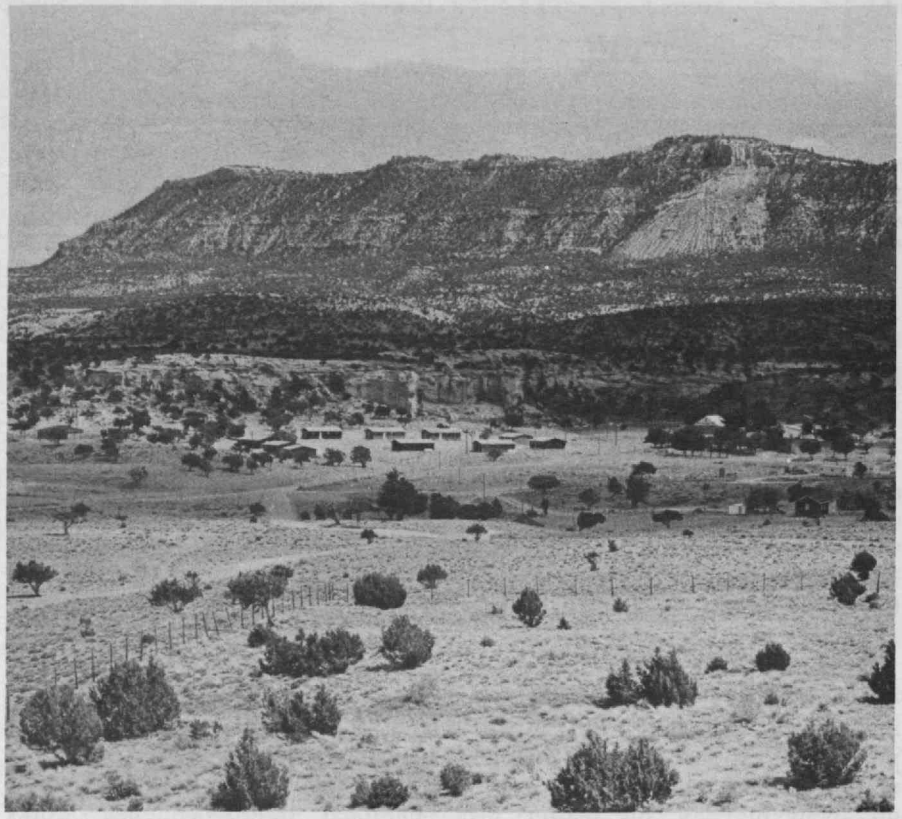
The space of a pueblo town focussed the people on each other. Privacy was difficult, except in the kivas. This lack of privacy had two aspects: it had a special impact on children, for they grew quickly to develop emotional ties with nearly everyone they saw about them; it was a strong conforming force among adults; even the beginning of a noncooperative or nonharmonious attitude in anyone was instantly noticed and pressure for conformity quickly felt.

But the need for conformity, for community cooperation in a common struggle and for common chaperonage and care have been diminishing during recent generations. The pueblos were remarkable for focusing energy toward succeeding in a harsh environment—all their emotional interdependency works well for getting the job done, for clearing fields, for harvesting, and—in the past—for defense. Now they are secure. They no longer have any military enemies—they will never starve again, nor suffer from epidemics. The younger people are learning more and more about life outside the pueblo, but it remains difficult for many of them really to come to grips with surrounding American culture. Pueblo space tends to make people think of what they have in common rather than of what distinguishes them from each other. In contrast, our space often tends to separate us even though we desperately long to communicate effectively.

Pueblo space holds people together as a group but isolates that group and makes it difficult for an individual pueblo person to come to terms with Americanization and to relate to other people in ways that traditions have not valued. The patterns around the old pueblo centers show the painful change, the slow steps out of one spatial myth toward another, from one system of human interrelation to another. Aerial photographs of nearly all pueblos reveal these changes—at conservative San Felipe Pueblo, for example, new houses have abandoned much of the traditional orientation still seen in the pueblo center. New houses orient to the road, a connection to a vast network of communication and movement, a network without focus; no longer do they orient to something as immediate, as profoundly static, as the tribal center of the world. Yet the people who live in these houses still direct part of their lives toward that tribal center, just as they also direct part of their lives toward the road and the demanding, American culture that road represents.

Leslie White noted in 1929 that new individual houses in the Acomita Valley had "contributed more to the gradual but inevitable breakdown of the old tradition than anything else. . . . There is psychological disintegration taking place; the pueblo is tending to break up into family groups."

This dissolving of pueblo culture—the transformation of the old village forms—may well increase in all the pueblos, but none has yet totally abandoned its traditions. Despite generations of Catholicism in the Rio Grande pueblos, all maintain active vestiges of their own system of indigenous religious thought. There is still a powerful force of community solidarity. This coolness to Western culture is not merely a reaction against past Western maltreatment and indifference; it also grows from the still-vital ideals that pervade the people's relationship to their homelands, their ties to the landscape where their gods have lived. In the pueblo are the remembered and valued bonds and the places of harmony. The spatially dense old pueblos' centers are at once an outgrowth, a reinforcement, and a symbol of the compactness and encapsulated identity.



Rough Rock, Ariz., is a Navajo Reservation community of 400 sq. mi. with some 1,000 people in family encampments, some 100 miles north of Winslow. It is the setting of the Rough Rock Demonstration School, an elementary school started some seven years ago—an experiment—as the first Indian-controlled school in the U.S. Its success inspired the community to attempt a secondary school, the Rough Rock Community High School, to be built on the site from which this photograph was made. (Photo: George L. Claflen, Jr.)

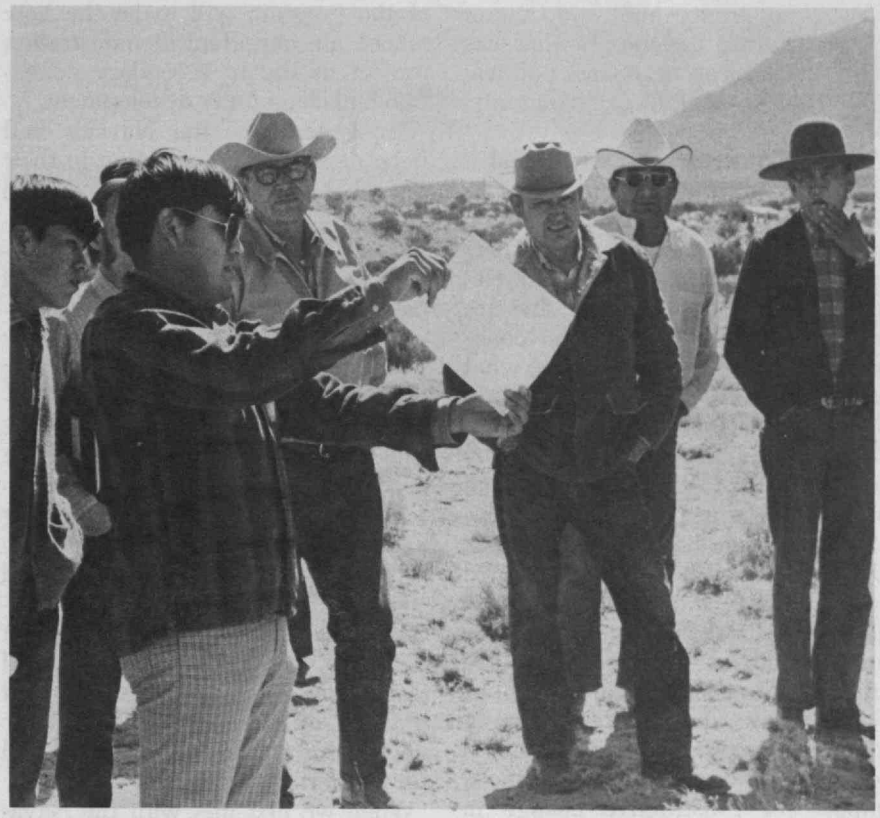
II.
Self Help: A Policy Study

This account will perhaps reveal to the reader how, during the rather lengthy duration of our pueblo study, we grew to regard the pueblo peoples (as well as other Indian groups we were coming to know—Navajo, Papago, Pima, Apache) as inordinately important people to other Americans. The study of their architecture made us realize the depth and strength of their daily cultural expression. And as we studied more and more the current state of their housing and the role of the federal government in their lives, it became dramatically clear to us, as it has to many others, that valuable people were being stifled and smothered; a kind of morbid dependency had developed in which the Indian people were the subject of policies that assisted and disrupted simultaneously.

One of the results of this understanding was a rather large study at M.I.T. to determine the potential of self-help as an approach to solving Indian housing problems—and to devise a viable self-help housing scheme with demonstration projects.

There is a tremendous need for improved housing among Indians. All studies have indicated that most of their housing is substandard. They, themselves, regard their housing as less than they need. The dimensions of the need are: of the 80,000 housing units in Indian communities, 70 per cent are well below any acceptable standard; and nearly 20 per cent of Indian families have

For generations the Navajos had been denied effective action in their own behalf. Now a demonstration school in the tiny community of Rough Rock, Arizona, has had an enormous impact for constructive change in American Indian education.



How may architects, from a tradition so different from that of the Navajos, help this community create a Navajo educational environment for a Navajo educational experience? As Indians and architects (including the author) worked together, they came to understand that the people should plan the educational environment themselves, that the architects could help them by raising issues and ideas; it was the architects' obligation to widen choice, not arbitrarily to limit it. (Photo: George L. Claflen, Jr.)

no housing of their own. In all 50,000 new units housing 300,000 people are needed.

We found among Indians many people with long traditions of self-produced housing—in fact, until a few years ago virtually 100 per cent of Indian housing was user-built. This is because among Navajos only 5 per cent of families have incomes sufficient to finance their housing on the open market; among Pueblo peoples the number comes to 10 per cent; and among Alaskan natives it is 2 per cent.

We concluded that the Indian peoples have the motivation, capability, time, and vision to produce their own housing. The poor condition of most of the existing housing stock today results in part from the transitional state of Indian cultures, in part from poverty. Indeed, we know that poverty is common to almost all Indian peoples. In certain pueblos, up to 80 percent of the families make under $3,000 per year. Among the Navajo, 7,000 sheepherding families make an average of $1,200 to $1,500 per year with a maximum of $2,000 per year. Recent estimates have 60 per cent of all Navajos unemployed and predict 75 per cent by 1975.

Changes are occurring in Indians' patterns of subsistence living, in their technology, in the kinds of materials available, and in their notions of housing, transportation, education, health, hygiene, etc. Yet these peoples place a high value on the integrity and independence of their lives. They feel that they know best what they want at this stage of their culture, and they resent the imposition of direction from outside agents and institutions. The types of assistance programs acceptable to them are those which increase the resources available to them and allow them to choose their own pattern of response to changing needs and desires. Housing programs which limit this freedom of choice and activity are counterproductive, since they are discouraging and frustrating.

As we learned these things, building the Indians' own community housing capacity evolved as a primary goal of the study. We defined community housing capacity as the ability within the resident community to procure and maintain its housing on a self-sufficient basis. This self-sufficiency does not exclude assistance from outside sources; it

does, however, suggest that the people themselves hold, and use, the power to initiate, to plan, and to manage the procurement and maintenance of their housing. We devised a rather comprehensive housing system which would offer an alternative to the present pattern of federal programs. This plan included housing budgets to the communities and families involved, supportive consulting inputs when needed from advocate teams and housing coordinators, and development of community economic activities related to housing.

We were interested in the self-help process because we, like others, thought this would provide a user-determining option to the federal programs that aimed at increasing the *supply* of housing (that is, subsidize or protect developers) rather than increasing the *demand* for housing (that is, improve the income of those on the reservation). This subsidization—through mortgage insurance—of the developer and not the user was in fact merely creating another kind of consumer-be-damned marketplace—where user needs and concerns were effectively thwarted as autonomous branches of bureaucracy sought to protect their power and developers their profits and privileges. Self-help might avoid much of this.

We were able to observe at reasonably close hand the government's and community's interactions, and we were awakened to many impediments to self-directed community programs; but we were not working directly with a community itself, which we eagerly hoped to do. We did some work with a Blackfeet group on housing, but the really interesting work to me has been our current activities with the Navajo community of Rough Rock, Ariz., assisting them with the planning and design of a program and facilities for a high school. This school embodies with extraordinary effectiveness the self-help principle on a community-wide basis.

III.
The Rough Rock School
As a Planning Process

Rough Rock is isolated at the northern base of Black Mesa in the midst of the desert and mountains of the Navajo Reservation. The Navajos are America's largest tribe; the reservation is slightly larger than West Virginia and contains over 120,000 people. Most still speak Navajo; many speak no other language.

About 1,000 people live in the 400 square miles of the Rough Rock community, scattered across the desert or up on Black Mesa in family encampments made up of houses (called hogans) and sheep corrals. Usually these encampments are a minimum of ¼ mile apart, often much more.

A trading post was built in the 19th century near a spring in a canyon cut into the escarpment of Black Mesa. This gave its name to the whole community and in fact created a trading community that has since become a social and political and now an educational community.

Toward Constructive Educational Change

The Rough Rock Demonstration School was built some seven years ago near the trading post; an elementary school, it was the first Indian-controlled school in the country. It was an experiment to see what would happen when Indians ran their own schools. In fact, it was an attempt to wrest control of Indian education of Indian children from white government bureaucracies.

Since its founding the Rough Rock Demonstration School has gained national and international prominence for its development of a bilingual, bicultural approach to the educational needs of the children of Rough Rock, and for its success in implementing the community school concept. It has had an enormous impact for constructive change in American Indian education.

And it is more, for the existing elementary school at Rough Rock is *the* major institution of the community. It is the largest employer. It is the only daily public gathering place other than the trading post for almost 20 miles. It is a place for shelter and companionship as well as for concrete assistance in time of need. Functions which might occur at many places in a larger town—functions such as health services, automobile repairs, sale of supplies, eating, working, and meeting people—occur at the Demonstration School.

So the school is more than a place for teachers and students and classes; it is a rather pure vehicle for general community expression, a place for everyone. It is not in any real way apart from the community—it is nearly a community in itself. As an old woman said, "The school is where we go when we need help."

Extending the Principle

Encouraged by this success, the community of Rough Rock has now taken a further step: extension of the Demonstration School program to secondary-school level through the development of a new Rough Rock Community High School.

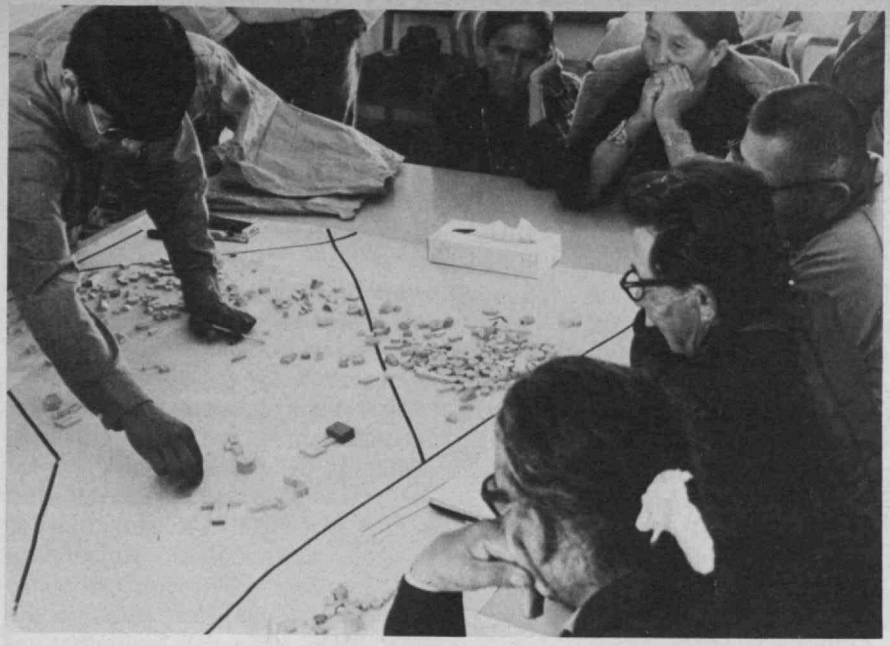
This is to be the first secondary school planned and operated by Indian people. Moreover, the nature of the program will make the new school an important demonstration project in Indian secondary education and community development.

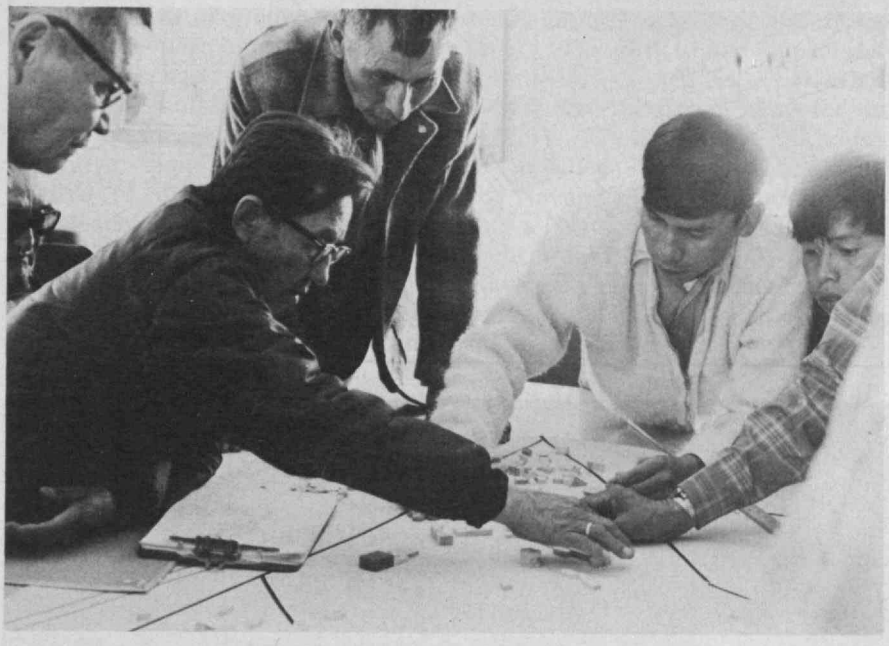
For generations the Navajos had been denied effective action in their own behalf; whatever action had been taken had been in disconnected and counterproductive fragments following federal operational patterns. Now the people are steadily and surely changing this. They seem to be in the process of forming their high school as a general community development instrument. The school is becoming a device for producing housing—a way of learning about housing design, financing and construction—as well as a way of making jobs for unemployed Navajos. It is catalyzing the formation of a cooperative store and a furniture production enterprise, and these—together with the actual building of the new school—will be devices for vocational education and for furthering Navajo culture.

When we first met with the Navajos of Rough Rock in August, 1970, they said they would like us to design a *Navajo* educational environment for a *Navajo* educational experience. We said no, that we were not Navajos and we could not design *for* them. But they said they would value M.I.T.'s help, that they did not trust the Bureau of Indian Affairs to help them nor were they confident they knew how to evaluate independent architects.

As we talked we came to the agreement that the people should try to design the environment themselves and that we could help them by raising issues and presenting ideas, alternatives, background facts and concepts.

We at M.I.T. conceived our primary objective to be to widen choice





Finally, after articulating and interweaving as many issues concerning the new high school as the architects and Navajos could think of, a group of Navajos gathered to work with model materials. There then developed a kind of dialogue: the Indians worked with the architects' alternatives to discover their own choice of direction, and then the architects started the cycle over again with a new set of alternatives at a more detailed level of thinking. This process continued off and on for 12 months before a design for the Rough Rock Community School was perfected. (Photos: George L. Claflen, Jr.)

and to widen the opportunity to choose; it was our obligation not to limit choice arbitrarily. Whatever technical competence or wisdom we might have did not entitle us to ascribe or dictate values to the people of Rough Rock. But the crucial question was how to proceed, by non-arbitrary steps, from a general objective to a specific program and physical space. And how to start work quickly, for the people at Rough Rock were impatient and wanted to act.

The question was particularly difficult because the Navajos have not had in their traditional culture a formal institution like a school; the only reasonably permanent architecture they erected were their housing clusters of hogans and sheep corrals.

A Twelve-Month Dialogue

Our first step was to hold a series of ten seminars at M.I.T. These were attended by anthropologists, linguists, educators, architects and Indians—their purpose being to prepare to better understand what we would experience at Rough Rock and to help prepare materials we could use there.

We learned much from the seminars, but things were still rather ragged when five of us—three students, the project coordinator, and I—went to live at Rough Rock for several weeks. We were there to gather, by a variety of means, the community's ideas; we used interviews, observations, model-building, sketches, slide shows and discussions, site visits, open community discussions, trips to see places and buildings that they liked and didn't like or that we thought were instructive.

While we were there the community organized itself into study groups to handle various sets of issues. Periodically we would try to summarize what we thought they were saying; and periodically they would tell us we were or were not understanding them—only this was always done very subtly, rather indirectly as a rule.

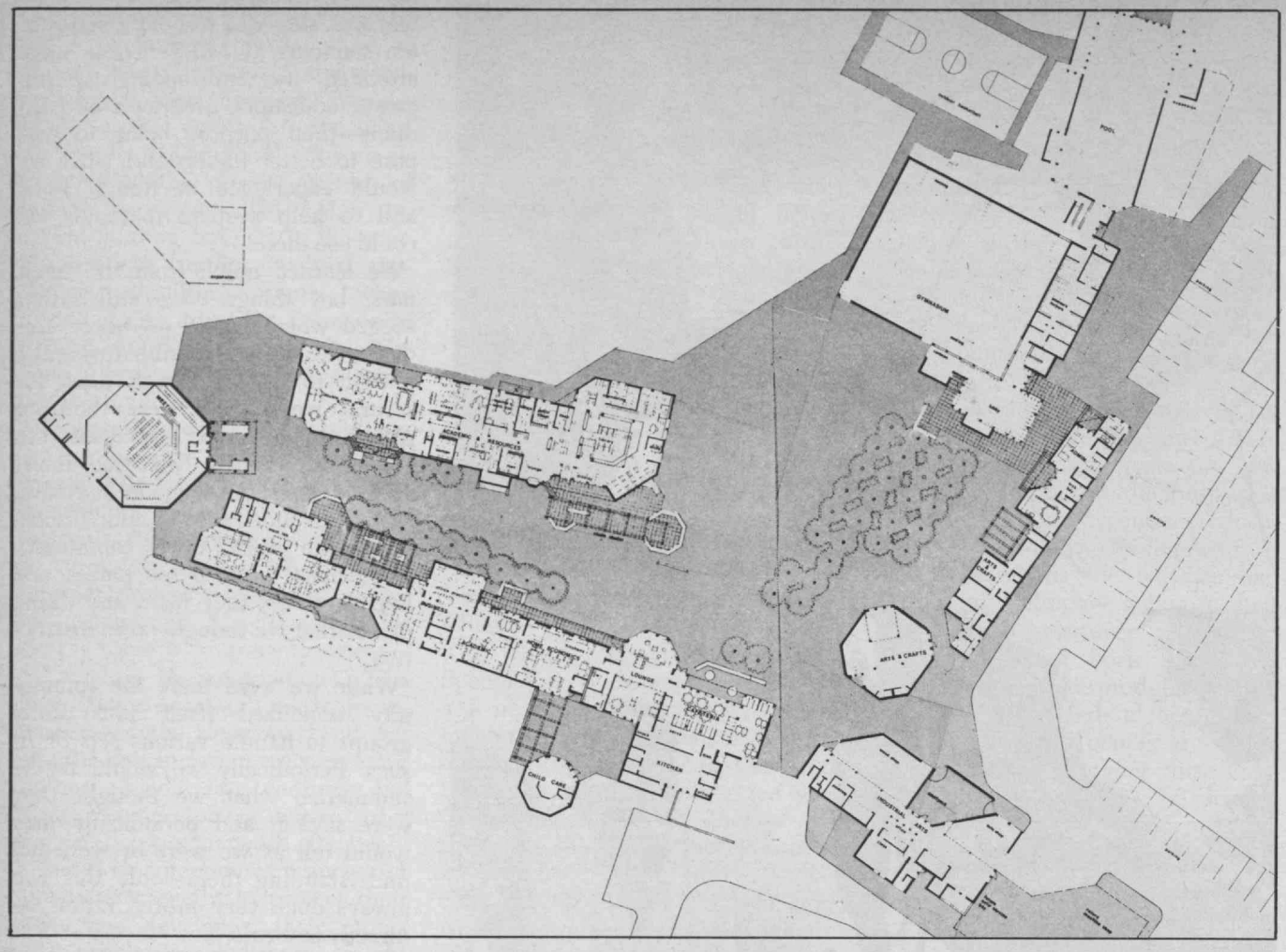
We returned to M.I.T. and worked over the material to piece together its main idea, to understand the logic and direction of their thinking.

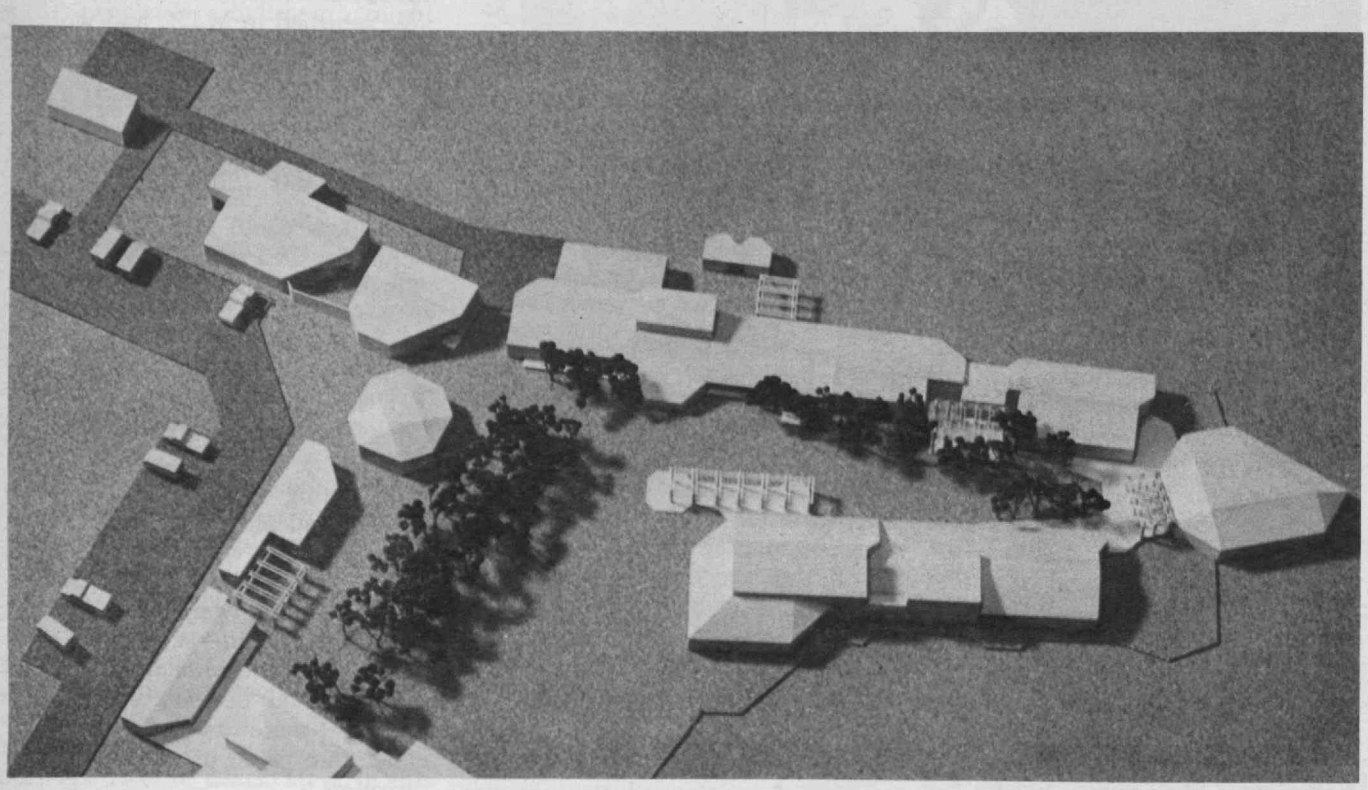
We then went back for more weeks of discussion of the alternative ways their ideas could add up to architecture for their school.

Finally, after articulating and interweaving as many issues as we and they could think of, a group of them gathered together for a few days with model materials and worked out a site plan. We then took the plan and developed alternative ways of executing its details. We developed a kind of dialogue: the Navajos would work with our alternatives to discover their own choice of direction, and we would then start the cycle over again—each time at a more detailed level of thinking; that is, we would develop yet another set of yet more detailed alternatives which they could use to evolve their direction.

The process continued until—after 12 months—we had finally all zeroed in on a completed design.

Since then we have been working





The Rough Rock Community School as now designed has many architectural qualities: the buildings and the spaces they define are meant to be casual, versatile, and neither institutional nor repetitive. Hogan-like forms are planned for school activities related to Navajo cultural and domestic life—arts and crafts, child care, and the meeting hall. But less indigenous activities—athletics and industrial arts, for example—will take place in structures less "Navajo" in character. So the high school will consist of a composition of Navajo and non-Navajo forms intermixed. (Photo: Stephen Baker)

on cost estimates, code reviews, and working drawings with Pacheco and Graham, Albuquerque architects who now have the major responsibility for technical execution of the buildings. The community has also spent much effort preparing for fund raising aimed at the federal bureaucracy in Washington.

The school which the community designed has many qualities, for there were many ideas developed by the various members of the community and nearly all of them were accredited by the community at large. These numerous qualities, both interior and exterior, are meant to add together into one overall architecture that fosters a wide range of choices—especially choices among many possibilities for following individual curiosities, on the part of any student or group of students and on the part of any teacher or group of teachers.

Thus the buildings and exterior spaces are meant to be casual, non-repetitive, non-"institutional," permissive of differences in learning and teaching styles from time to time within the life of the school and from place to place within the school at any one time—i.e., to provide a wide variety of student and teacher settings, ranging from individual "private" spaces through collective and "public" spaces. None of these spaces is meant to be like any other. The non-repeating spectrum of spatial qualities is meant to support the school's objective of "individual learning," of providing a Navajo education experience in a Navajo environment.

The people of Rough Rock are quite clear in stating that Navajo spatial qualities include:

☐ No interior corridors, no limiting exterior walkways—looseness, openness.

☐ Varied shapes and relationships between buildings and space.

☐ Awareness of relationship of interior spaces to land, including easy access to the outdoors and the ability to see important places in the landscape.

☐ Buildings in sympathetic relationship to the land through colors, textures, forms, dimensions, scale, all of which are intended to harmonize with the surroundings.

The traditional Navajo residential cluster of hogans, shade shelters, and sheep corrals can be described in terms of these same general qualities. Thus the design of the high school relies on two traditional Navajo forms—the regular polygonal and concentrically organized hogan and the shade shelter, a scaffolding of logs covered in the summer to provide shade.

Those activities of the school similar to Navajo domestic life were thought to be particularly well housed in hogan-like forms. The arts and crafts building and the meeting hall strongly resemble the traditional many-sided hogan, while many other spaces have elements that recall the hogan form. In addition, five wooden scaffoldings meant to resemble shade shelters will be built to cover various outdoor events—arts and crafts, celebrations, displays, lounging, theater, etc.

Pure Navajo forms were thought by many of the people of the Rough Rock community to be inappropriate for certain functions (basketball, swimming, industrial arts, for example). These are instead housed in so-called "Anglo" spaces. Thus the Navajos of Rough Rock thought that a "Navajo" educational environment would have Navajo and non-Navajo forms mixed—but in harmonious relationship to each other and to the landscape.

Architect and Community

I have described some of the main ideas of the design of the Rough Rock community high school. What interests me most, however, is not the design but the way of designing it—a way that tried to maximize community expression of community values, to pass the opportunity, responsibility and reward of authorship from the professional designer to the community.

The explanation of the process in this article has been somewhat perfunctory, but that is in part because the process was rather ragged, ultimately somewhat *ad hoc*, without a sound foundation of well-tested theory and method. Although advocate planners and architects have recently been working with many community groups throughout the country, no broadly tested or accepted theory or method has yet been developed by the architectural profession nor by the schools of architecture that I know. The procedures and vehicles for working with community and user groups are where genuinely creative and sound work needs to be done by architects and schools. Procedural subtlety and inventiveness may now be more important than technical competence; certainly they are more important than formal inventiveness. The new procedures must—and will—provide the paths by which architects can work for their communities—in this case Indian communities—to release the stifled variety and wisdom and sensitivity lodged in those people so that their values and ways can become fully expressed for the benefit of them and of all of us.

Acknowledgments

The pueblo study reported here was supported by grants from the Ford Foundation and from the Joint Center for Urban Studies of M.I.T. and Harvard University.

The self-help housing study was prepared at M.I.T., with the Association on American Indian Affairs, for the Organization for Social and Technical Innovation, Inc., under its contract with the U.S. Department of Housing and Urban Development. John Ames Steffian, Associate Professor of Architecture at M.I.T., was Co-Director of the project; Robert Parker and Marcie Setlow were Research Associates. Various students and consultants—among them Janet Keeping, John Davidson Miller (planning consultant), Joan Taylor (editorial consultant), and James Wallis (planning consultant)—contributed valuable effort and ideas.

Perhaps 30 per cent of the total population of Rough Rock has made direct contributions in one way or another to the design of the Rough Rock Community School; the School Board, students and staff of the School, and several members of the community have played centrally important roles. Elmer Nix of Arizona Western College was education consultant. Some 20 M.I.T. graduate and undergraduate students participated as part of their educational programs, and seven students from the American Indian Program in the Harvard Graduate School of Education and five from Radcliffe College were consultants. Professor Steffian was planning consultant, and George L. Claflen, Jr., fulfilled the difficult task of joining all these participants into an effective planning process as project coordinator.—*C.L.S.*

George A. W. Boehm

After D.D.T., What?

For the first time in history a great many Americans—maybe a majority—have grown up without ever having seen a crop harvested. They are affected by the "supermarket syndrome." That is to say, they take for granted an abundance of well-washed food, free of the slightest blemish. A mere 30 years ago a cook making a pie thought nothing of finding a few worms in a bag of apples or peaches; she simply cut around the wormy parts. Today her daughter or granddaughter won't buy a piece of fruit with a skin-deep discoloration.

Meanwhile, a whole generation of farmers has come to believe that, with a few exceptions such as bees, the only good insect is a dead insect. At the same time, most people are horrified by the thought that their food may contain microscopic traces of insecticides and other chemical residues.

What everyone expects is a miracle. It might take the form of a chemical compound—preferably as inexpensive as table salt—that eradicates all "bad" insects without harming the "good" ones. It should also be safe enough for warm-blooded animals and fish to eat or should disappear a day or two after it is applied. In the present mood of the country, lesser miracles are unlikely to be acceptable either to farmers or to consumers.

Current attitudes toward insect control were established back in the early 1940s by what appeared to be a major miracle of chemistry: the discovery that D.D.T. killed insects cheaply, effectively, and apparently without menacing other species. When the miracle developed flaws—chiefly insect resistance—it was swiftly repaired by the discovery of similar compounds, such as methoxychlor, that could control D.D.T.-resistant insects. And so, it appeared that the miracle could be perpetuated by changing the molecule a bit so as to stay one step ahead of the changes in insect susceptibility.

George A. W. Boehm is one of the nation's pioneer science writers. He has held positions with the American Chemical Society, *Newsweek*, *Fortune*, and the *Scientific American*, and is now writing on a free-lance basis.

A Can of Tomatoes Plus

Now the nation is confronted by an end to this particular age of miracles. Many insects have developed resistance not only to D.D.T. but to most other chlorinated hydrocarbons. Besides, it has turned out that insecticides may be extremely harmful to unrelated species—so much so that many people concerned with environmental problems argue that potent insecticides should be outlawed.

Science has done it again: to itself. The public is disenchanted, to say the least, with current methods of insect control. Moreover, it is impatient. And science and technology are bitterly blamed for not furnishing ideal solutions to a complex problem that is not purely technical but also has important social and economic aspects.

Altogether better ways of coping with insect pests are being developed. They will be made ready for use gradually. The degree of safety and effectiveness that D.D.T. at first apparently gave the world may not be attained before the end of this century. Meanwhile, the people of the U.S. will have to put up with conditions that many will find barely acceptable.

Farmers and consumers alike will have to learn more tolerance toward insects and worms, for a nation deeply concerned with the purity of air, water, and especially food will no longer condone the massive applications of insecticides needed to eradicate pests. The only practical solution, for the time being, will be a state of armed truce, with outbreaks of guerilla warfare. Insects will be controlled by occasional use of chemicals in smaller amounts, but growers will no longer attempt to eliminate most pests entirely. Since crops will not be devastated, city dwellers will still have wholesome food at reasonable prices. But as one vegetable grower has warned: "You may have to put up with a little 'meat' in a can of tomatoes."

Why D.D.T. Is Defended. . .

The early stages of this new way to wage war on insects have been highlighted by all-out attacks on D.D.T., the chemical that first made possible virtually complete eradication of worms and insects. D.D.T. is now on trial for its life. It stands accused of polluting the environment, poisoning wildlife, and subtly menacing human health. Hearings by the U.S. Environmental Protection Agency (E.P.A.) began last August and lasted six months; in June, the Agency banned nearly all uses of D.D.T. effective December 31. But it will probably be mid-1973 before court appeals are exhausted and the verdict is final. If found guilty, D.D.T. will be banned for all, or almost all, agricultural uses throughout the U.S.

Strange to say, the fate of D.D.T. is not really a major issue. It has been headed for oblivion for several years, partly because many pests are now immune to it. Also, environmentalist groups in Wisconsin, Michigan, Arizona, New York, and Cali-

If we can accept a few spots and bugs on our produce, we can do without D.D.T., and agriculture can be more profitable and more pleasant. The skills to be learned are blending several kinds of pest control and using only what controls are absolutely necessary.

Area or Nation	Pesticide use (grams per hectare)	Rank	Yield (kilograms per hectare)	Rank
Japan	10,790	1	5,480	1
Europe	1,870	2	3,430	2
United States	1,490	3	2,600	3
Latin America	220	4	1,970	4
Oceania	198	5	1,570	5
India	149	6	820	7
Africa	127	7	1,210	6

How much pesticide a nation uses has a highly non-linear relation to the amount of agricultural produce it harvests per acre, as this table prepared by the United Nations Food and Agricultural Organization shows. Japan uses ten times as much pesticide as the United States and harvests twice as much food per acre; we in turn use 11 times as much as Africa, with yields, again, twice as great.

fornia have succeeded in outlawing its use on pastures and most food crops. The Federal Food and Drug Administration has clamped down on D.D.T. residues in foods shipped in interstate commerce.

This year more than 70 per cent of the D.D.T. used in the U.S. will be applied to only one crop, cotton, and then only in the Deep South and the Southeast. Even there it has few devoted friends. David Young, a Mississippi farm extension service entomologist, testifying in favor of D.D.T. at the E.P.A. hearings, pleaded for "just three-to-five more years until we can develop a better substitute against the boll weevil and the boll worm."

Before the hearings ended, the E.P.A. and environmentalist groups (notably the Environmental Defense Fund) were preparing similar cases against several other "first-generation" chlorinated hydrocarbons chemically akin to D.D.T. All persist in soil and water for months or years, retaining much of their potency. Most have been blamed for killing wild birds and fish. None is acutely toxic to man, but some are suspected of being slow-acting hazards to human health. All are cheap compared with other insecticides. If D.D.T. is finally convicted and banished, precedents will be set to ban other chlorinated hydrocarbons with names such as dieldrin, aldrin, mirex, toxaphene, and heptachlor. Sooner or later, entirely different kinds of insecticides may also be attacked. It is for this reason that D.D.T., though in its dotage, is worth fighting over.

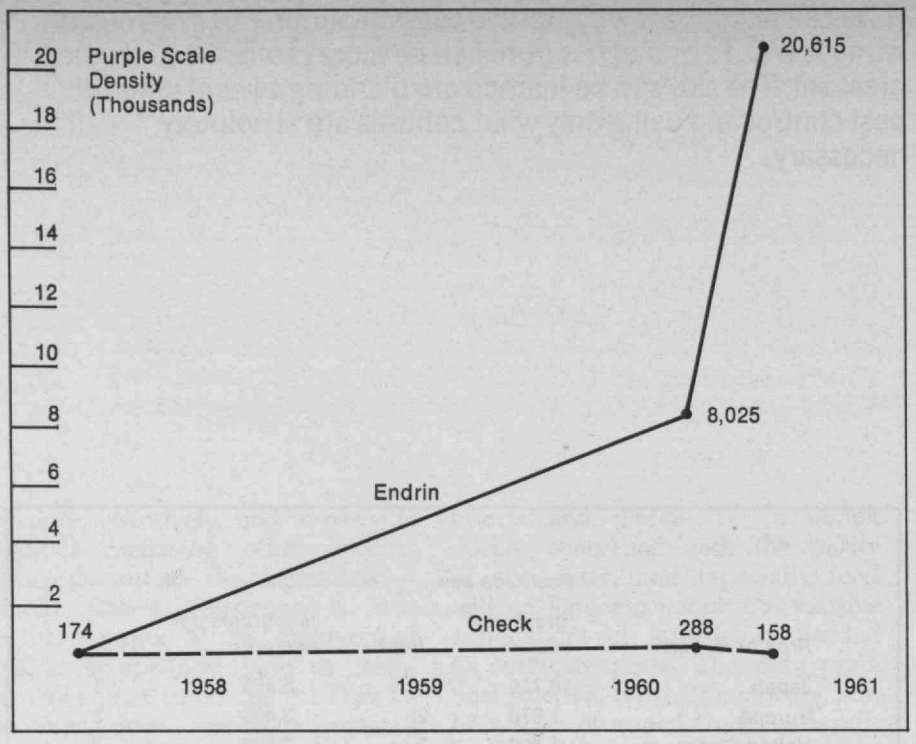
. . . And Will Continue to Be Made

The chief defense for D.D.T. was presented by lawyers representing 27 chemical companies and the U.S. Department of Agriculture. One company that was *not* a party to the proceedings was the Montrose Chemical Company of California, the only remaining U.S. manufacturer of D.D.T. Montrose produces roughly half the world's supply in one medium-sized factory in Torrance, just south of Los Angeles. Almost 90 per cent of its output is exported to countries where the World Health Organization regards D.D.T. as essential for controlling malaria, typhus, bubonic plague, and other insect-borne diseases. For this reason not even adamant environmentalists want to force Montrose out of the D.D.T. business. Some also concede that countries whose food supply is less well-assured than the U.S.'s should probably continue to use D.D.T. and other insecticides, regardless of risks to wildlife and human health.

Even in the U.S., the results of using D.D.T., other than contamination of the environment, are worth considering. In fact, the risk of hastily abandoning too many insecticides may be greater—and much harder to evaluate.

If the chlorinated hydrocarbons are banned, as now seems likely, the chief remaining chemical weapons against insects will be the "second-generation" compounds: the organophosphates and carbamates. These newer insecticides are better in one important respect. They evaporate or decompose so quickly that not a trace remains after a few days or, at most, a couple of weeks. Thus they do not accumulate in water or soil, nor do residues remain in harvested food crops.

But the second-generation compounds also have serious drawbacks. They are acutely toxic to man and other warm-blooded animals. Some, in fact, are so deadly that they have to be applied by experts wearing coveralls, rubber gloves, and gas masks. Carelessness and accidents have caused dozens of serious hu-



How shall we control the purple scale, *Lepidosaphes beckii*? Use of endrin as an insecticide actually resulted in an increase of scale infestation, because the endrin caused the demise of the single parasite species affecting the scale. Untreated trees (dashed line) benefitted from biological control. (Chart: Huffaker, Biological Control)

man illnesses and deaths. And some of the organophosphates wipe out rabbits, pheasants, and honeybees, which are not seriously harmed by chlorinated hydrocarbons.

The carbamates and organophosphates also make farming economically more precarious. The difficulty and risk of applying them puts the small farmer at a further disadvantage in competing with large corporate farming operations that can afford to hire pest-control specialists. Thus the banning of the easy-to-use chlorinated hydrocarbons could speed the disappearance of family farms.

Because they must be applied frequently and cost much more per pound, the second-generation insecticides may contribute to a slight rise in the cost of food. Any abrupt dislocation of U.S. farming methods might further unsettle our balance of trade, since the worrisome deficits of recent times have been kept within bounds only by huge exports of agricultural products.

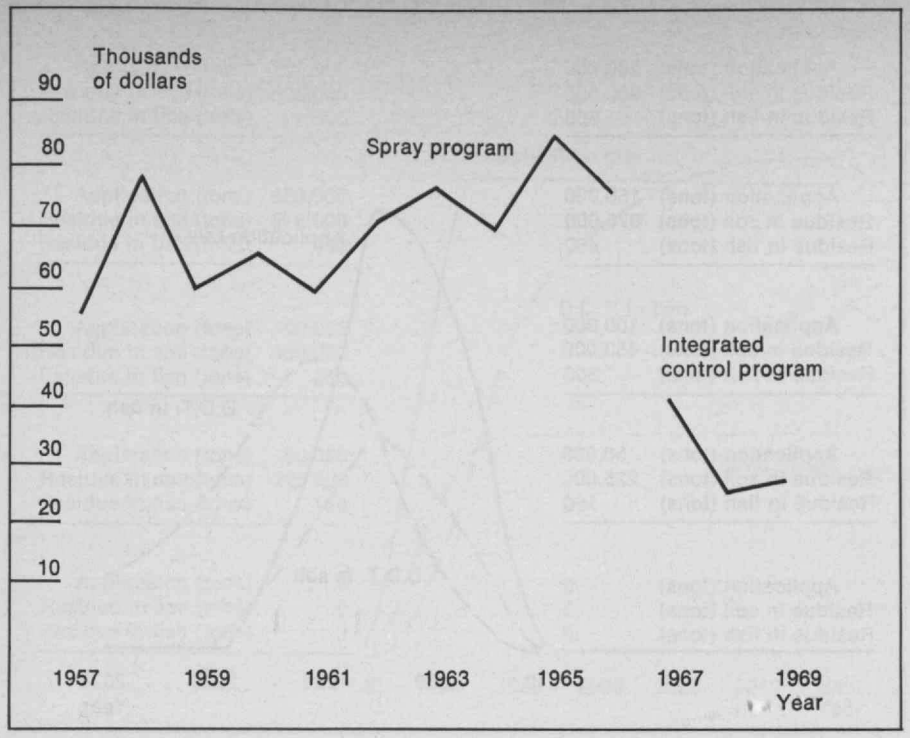
Thank the Vedalia Lady Beetle

Since none of the present insecticides is close to being ideal, some environmentalists want to phase them out rapidly and entirely. They would rely on purely biological stratagems to minimize crop damage, and they point to a number of cases where biological control has triumphed. For example, an insect-eating insect, the vedalia beetle, was imported from Australia in 1888 and saved the California citrus industry from destruction by a tiny sucking scale. In 1955, screwworms infesting cattle on the Caribbean island of Curaçao were thwarted by the release of millions of adult male flies previously sterilized by gamma rays from radioactive cobalt. They mated, but the females laid eggs that did not hatch, and within a few generations the screwworm was virtually extinct on Curaçao. About the same time an exotic beetle from Europe threatened the entire U.S. alfalfa crop, but Department of Agriculture scientists found a different variety of alfalfa that proved unpalatable to the invaders.

Unfortunately, widespread insect control by purely biological means is still a dream unlikely to come true during this century. Of the 1,250 insect pests in this country, fewer than 100 can yet be partly checked without the use of chemicals. There is not even assurance of steady progress. The screwworm program that worked so well on isolated Curaçao has been only moderately successful in the Southeastern U.S., because areas where eradication has been started are soon swarmed over by virile males from as far as 150 miles away. And last year citrus orchards in south-central California were attacked for the first time by the Comstock mealy bug, a pallid grub about three-eights of an inch long. Parasites were brought in from Florida and Japan, where they have controlled this pest, but they did not thrive in California, and so an emergency program of heavy organophosphate spraying was necessary to save the crops.

In some cases, biological control is spectacularly successful—up to a point. On a recent tour of the central valley of California, I met Sid Long, who raises walnuts on a 320-acre ranch near Modesto. In 1971 Mr. Long decided to strew his orchards with flea-sized wasps that feed on aphids. (The wasps are sold in ice-cream containers by commercial operators who breed them.) He told me: "The wasps did a fantastic job for quite a while, but suddenly in late July they took a vacation—became dormant and disappeared. We had to put on parathion in a hurry when the aphids rushed in, but it was the first year we were able to delay spraying until late in the growing season. Actually, the wasps saved us a lot of money."

In mapping out the near-term future of insect control in the U.S., the Environmental Protection Agency is faced with a task requiring much more knowledge than is available, and perhaps more wisdom than any group can muster. The Federal law governing the regulation of insecticides requires the E.P.A. to weigh all risks and benefits—social and



Integrated pest control uses all suitable techniques to manipulate pest populations so that they do minimal injury. Such a control program, using several harmonizing techniques, is often safer as well as more economical than general spraying. This chart compares the cost of programs to control insects and mites on 1,000 acres of apples. (Chart: Huffaker, Biological Control)

economic as well as ecological—and to take into account practical alternative approaches to insect control. Many leading scientists doubt, however, that the regulators have nearly enough facts to do the job well, even in the case of D.D.T. At times the D.D.T. hearings degenerated into debates on the order of two schoolboys yelling back and forth: " 'Tis" and " 'Tisn't." In summarizing a 1971 review of the ecological effects of pesticides, Edward David, Jr., the presidential science advisor, expressed his uneasiness thus: "Overall I am less than pleased with the information available, and the review clearly points out the desperate need for intensive investigation." The E.P.A. was under pressure to make decisions promptly without waiting for further knowledge. The widespread public mistrust of D.D.T. in particular and insecticides in general, although it has no legal standing, probably swayed harried administrators.

While scientists, administrators, and lawyers continue to wrangle over matters of fact and interpretation, a great deal of progress is being made in the search for wholly practical solutions to the woes of insect control. The restrictions already imposed on the use of insecticides and on their residues in foods have stimulated a change almost as far-reaching as the change begun by the introduction of D.D.T. itself. Farmers are finding that it often pays to use more biological controls backstopped with the judicious use of chemicals in limited quantities. National statistics reflect the trend. After increasing by 10 to 15 per cent each year for a decade, the use of insecticides has leveled off since 1969.

Thank California Scientists

What has happened is that the most skillful farmers, coached by agricultural researchers, are learning to apply chemicals only when necessary to avert massive damage to crops. They accept a limited amount of insect damage, and they rely more on insects' natural enemies to check losses. Generally they save money, for each application of a spray or dust costs $20-45 per acre. In a good many cases yields have gone up rather than down, because at certain stages of a plant's development the insect-eating insects are permitted to flourish, and they often work more thoroughly than insecticides.

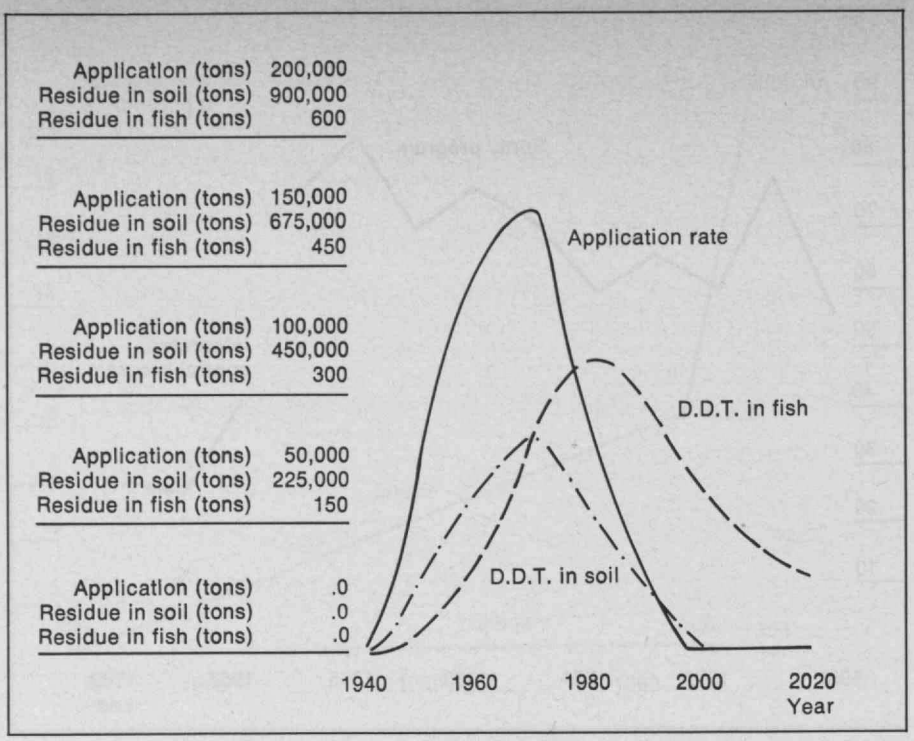
City dwellers and others with the supermarket syndrome may find fault with the trend to less chemicals and more insects. If a farmer permits some of the pests to live instead of trying to slaughter them all, there are bound to be some holes gnawed in leafy vegetables and some puckered spots in the skins of fruits. But in a world caught between anxiety over environmental contamination and food shortages, the supermarket syndrome is a state of mind that the nation can hardly afford any longer —especially if the new go-easy farming methods produce more wholesome and more abundant food than ever.

The modern strategy of combining sound ecology with the studied use of chemical insecticides dates back to the late 1950s, when agricultural research scientists of the University of California began speaking of "integrated control." They made little headway until the drawbacks of purely chemical control became obvious a few years ago.

Now with the spreading restrictions on the use of insecticides, the enthusiasm for integrated control has caught fire across the nation. But California remains the main proving ground for a number of reasons. With close to 15 per cent of the nation's total crop production—including every major U.S. crop except tobacco and soybeans—it has an enormous stake in agriculture. Its extensive university and farm extension system is well-financed to do research and help farmers solve practical problems. In addition, many California farms are large enough to afford the trained staffs and special equipment needed for experiments to adapt integrated control to local conditions. To provide similar help to smaller farmers, the State Department of Agriculture this year created a new cadre of professionals.

Called Agricultural Pest Control Advisors, they will be specially trained and licensed in time for the 1973 growing season.

Integrated control was put to its most critical test yet when, after the 1970 growing season, California outlawed the use of D.D.T. and most other potent chlorinated hydrocarbons on cotton. The state has long been among the nation's top cotton producers, and yields per acre are phenomenally high. By that time the Agricultural Experiment Station Experiment Service was ready with an elaborate campaign strategy for combatting the more than a dozen insect pests that attack California cotton. Many of the details had been worked out by Professor Robert van den Bosch and his associates at the University of California at Berkeley. A sympathetic grower had allowed them to experiment freely with more than 2,500 acres of his cotton—a crop worth at least $500,000—and even to leave a quarter of the fields entirely untreated for the sake of scientific comparisons.



What will happen to residues of D.D.T. if its application worldwide is either stopped or continued at its 1972 rate is predicted in these sets of curves made by a computer simulation set up by Jørgen Randers, a graduate student in M.I.T.'s Sloan School of Management. Mr. Randers is a member of the Systems Dynamics Group that produced *The Limits to Growth;* the charts on D.D.T. use come from a paper to be published next fall in Britain in the *International Journal of Environmental Studies.* If application continues as at present, the D.D.T. residing in the world's fish will in 50 years be greater than at present.

Cabbage Loopers Don't Hurt!

When the 1971 crop was planted, the first pest to arrive, as usual, was *Lygus,* a small sucking bug that begins its depredations in June. *Lygus* is vulnerable to an extremely powerful organophosphate called parathion, but so are cotton plants. If this is applied near the height of the blooming season in late July, it reduces the yield of cotton bolls. And so growers following the integrated control strategy sprayed only once or twice if *Lygus* infested their fields; then they stopped to allow blooming to proceed.

Some adopted an alternative that van den Bosch favors: to lure *Lygus* to a plant that it greatly prefers to eat, namely, alfalfa. When they planted strips of alfalfa in and around cotton fields, the bug almost wholly ignored the cotton. But to make the most of this scheme, they had to keep the alfalfa well irrigated and lushly green, while stinting the cotton a little on water and fertilizer so it would not be too appetizing.

With spraying halted early, the plants bloomed bounteously, and plenty of natural predator insects were left alive and vigorous to cope with the next major pest: the boll worm. In some places the boll worms did not become serious enough to warrant the expense of chemical treatment. But where they did begin to cause considerable damage, they were sprayed repeatedly with an organophosphate. Once he started spraying, a grower got little more help from the predators. And so, cotton farmers were urged to judge whether boll worms were really doing enough damage to warrant the cost of several heavy insecticide applications.

Those who continued to follow advice found to their surprise that it paid not even to attempt to control a third pest, the cabbage looper. This worm concentrates on old leaves near the bottom of the plant, and although the damage is unsightly, it reduces the final yield of cotton very little if at all.

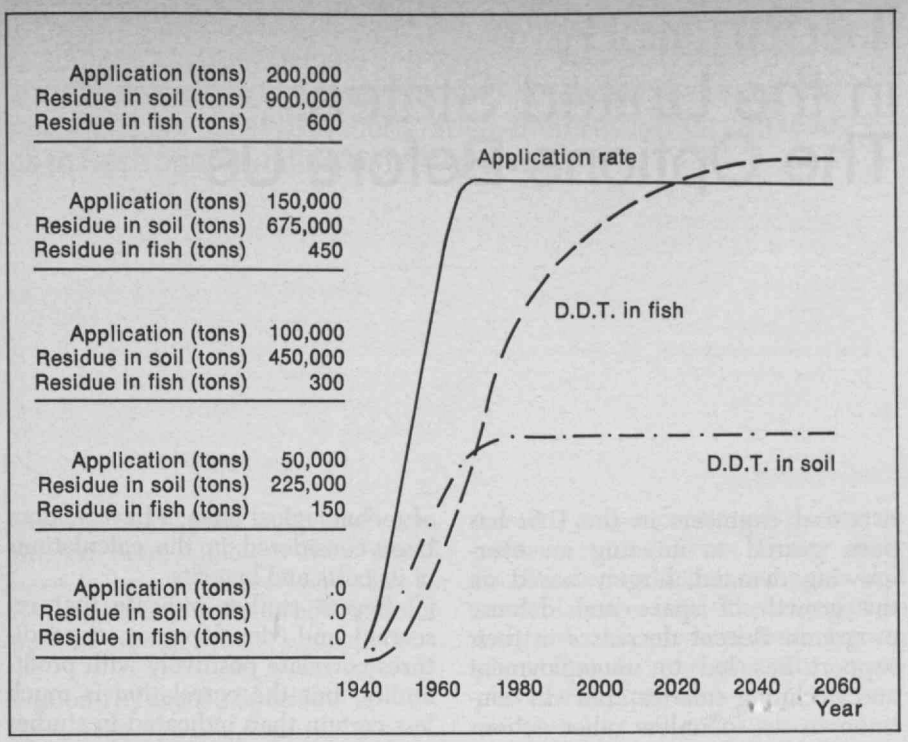
Still another pest, the beet army worm, appeared on schedule in early September, when the plants were putting on a final spurt of growth before harvest. This worm feeds on the tiniest bolls at the top, and it is not worth the cost of spraying in order to save that extra few per cent of the crop. Back in the days when D.D.T. was king, farmers used to eradicate cabbage loopers and beet army worms "just in case."

The California growers who followed this complicated battle plan had to put up with many more insects then they had been accustomed to in almost 30 years. But integrated control worked well, for 1971 was a season of bumper crops for most of them.

Integrated control generally requires much more skill, judgment, and close personal attention than purely chemical control carried out according to a fixed schedule. J. Hodge Black, farm advisor for Kern County, tells his farmer friends: "The one most important—and cheapest—thing you can put on a cotton field for pest control is your own shadow."

Integrated control has one serious drawback: it is not "exportable," as Dr. van den Bosch says. Every crop in every region poses a special problem. Cotton, for example, is grown in 19 states and attacked by some 130 insect pests. The boll weevil, the bane of the South, has never appeared in the West. What works in Southern California happens also to suit Arizona cotton, but even in New Mexico different tactics are needed.

To demonstrate this point to farmers and also to get additional integrated control programs estab-



If, however, the application of D.D.T. is gradually stopped over the next 30 years, the amount of D.D.T. in fish will return to its present level in 25 years and will be less than that in 50 years. Mr. Randers also predicts (in a curve not shown) that a complete, immediate D.D.T. ban would still mean some residues in fish after 50 years—that much time at least is needed to cleanse the food chain and other reservoirs.

lished, Dr. van den Bosch and a fellow Berkeley entomologist, Carl Huffaker, have launched a nationwide comparative research project. (Dr. Huffaker wrote "Biological Control and a Remodeled Pest Control Technology" for the June, 1971, issue of *Technology Review*.) They focused on four crops because they are widely grown under different conditions: alfalfa, apples, citrus, and soybeans. Then they added a study of the pine bark beetle to interest foresters. So far the Agricultural Research Service of the Department of Agriculture, the U.S. Forest Service, and 19 land grant universities are involved. The aim is to work out a complete integrated control program for each of the crops everywhere it is grown. As Dr. Huffaker explains: "We have to get across the idea that if you fight insects with only one method, they'll surely win."

A Little More Mediocrity

Before the program is completed, five or ten years from now, many new methods are sure to be available. Biological tricks by the dozen are under investigation. There is, for example, a new variety of cotton with slick leaves; when a breeze blows, boll worm eggs slip off onto the ground. A new strain of peanut for some reason does not whet the appetite of the fall army worm. The Agricultural Research Service has found a way to rear millions of tiny wasps that prey on the cereal leaf beetle, a pest newly arrived from Europe.

A third generation of chemical compounds is also being born. Although several of the large chemical companies dropped their entire insecticide businesses because of low profits and bad publicity, others have research scientists working on wholly new compounds that fit in well with integrated control principles. Generally, they are much more selective than their predecessors and less likely to harm other forms of life. One mite poison recently marketed by Uniroyal, Inc., is deadly to mites that eat orchard fruit but hardly at all injurious to mites that eat other mites. Applied in orchards where several varieties of mites live, the chemical swings the balance of nature in the grower's favor.

Zoecon, a California subsidiary of the Mexican drug manufacturer Syntex, is applying for permission to sell a synthetic substance that is a caricature of a natural insect hormone. This chemical interrupts the metamorphosis of a grub to a moth, creating a harmless monster that is half juvenile, half adult and unable either to eat or to reproduce.

Shell Development Company scientists are studying a class of compounds that seem to make flies and mosquitoes so lethargic they hardly bother to unfold their wings. As a killer of insects it is strictly mediocre, but many chemists are beginning to suspect that a little more mediocrity is a worthwhile goal.

The era of the all-purpose insecticides may be nearing an end. Nevertheless, some thoughtful scientists who have been anxious about the abuse of these chemicals are equally disturbed by the thought that they may be ruthlessly outlawed altogether. What is wrong, for example, with a persistent chlorinated hydrocarbon used for termite control? One application protects a building for about 20 years and does not stray into the environment.

The beginning of the end for D.D.T. was a 1969 report to the Department of Health, Education, and Welfare by a scientific panel headed by Emil Mrak, Chancellor Emeritus of the University of California at Davis. This report urged that D.D.T. be eliminated except for those uses essential to the preservation of human health and welfare. Dr. Mrak was worried by the possible aftermaths of the E.P.A. hearings over D.D.T. "I despise the idea of legislating or regulating against particular molecules," he once said. "We need be concerned only about abuses. The outlawing of D.D.T. would be a tragic mistake because right here in the U.S. we might need it for the very reasons the World Health Organization wants it—to control outbreaks of malaria, bubonic plague, or other epidemics."

Philip Handler, president of the National Academy of Sciences and a distinguished biologist in his own right, expresses the same kind of uneasiness: "To do without available pesticides, the price to man would be too high. We have no choice but to learn how to use the pesticides we have—to use them sparingly and wisely, rather than foolishly abolishing them altogether. Public panic is as completely unwarranted as concern is justified."

J. Herbert Hollomon
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Technology in the United States: The Options Before Us

In the first installment of this essay (*see "Issues for the 1970s in* Technology Review *for June, pp. 10-21*), we have identified and described a number of problems relating industrial progress, research and development policy, and scientific and engineering manpower which now confront the U.S. Briefly summarized, these observations are:

☐ The economy of the United States has evolved from agricultural to industrial to service-based. Past improvements in productivity have come largely from the agricultural and manufacturing sectors.

☐ The growing and widespread social consequences of industrial activity and the use of certain products have only recently begun to receive significant technical attention or government action and must be considered in the future industrial development of the society.

☐ As technology has spread throughout the world, competition from overseas has grown and can be expected to continue. The growth of the Common Market in Europe and the World Market for Japan gives to each of these economic units many of the advantages that the United States has enjoyed uniquely in the past.

☐ The system for educating scientists and engineers in the U.S. has been geared to meeting an ever-growing demand, largely based on the growth of space and defense programs. Recent decreases in their support has led to unemployment and declining salaries and will continue to do so unless other actions are taken.

☐ The prices paid for scientists and engineers have been inflated significantly more than other salaries and wages in the economy. The cost of all scientific and technical activity, whether aimed at increasing industrial productivity, improving technical capabilities, or dealing with social problems, has increased out of proportion to other costs.

☐ While support for research and development to improve health services and aviation has grown, total public expenditures supporting research and development for education, the criminal justice system, non-aviation transportation, health care delivery, and the disposal and treatment of waste are almost insignificant.

☐ Increases in productivity do not come directly from research and development alone; they involve experience in manufacturing, the supply of services, the diffusion of old technology, and public support for a social climate that encourages and adapts to change.

☐ There is a good correlation between industrial growth, productivity, and investments in research and development for many industrial activities; the correlation is less good for the electronics and aviation industries, which may be less effective in exploiting research and development than other industries that received less governmental support.

☐ Second-order indirect social costs of technological change have seldom been considered in the calculations of its costs and benefits.

☐ Recent studies indicate that research and development expenditures correlate positively with profitability, but the correlation is much less certain than indicated in studies made in the early 1960s; the profitability of research and development may have declined.

☐ Large investments in research and development are typical of growing industries and may contribute to their growth and profitability. Less dynamic and older industries support relatively less research and development, and this may further depress their growth.

☐ The primary processes of technical change, at least in relation to civil activities, may depend less on new research and development than on ingenious applications of old techniques in response to market demands.

We concluded that these issues in relation to present U.S. social problems make clear the need for revision of U.S. policies relating to technology and its use in the society. But we cautioned that our analysis of past policies also makes clear the need for a better understanding of the effects of research and development policy as we analyze future alternatives.

The several policy alternatives that follow are an attempt to enumerate possible courses from which we might choose in order to make more effective use of technology in society. Even though the studies and analyses of past policies are inadequate, our present situation clearly demands the consideration of immediate action. The options presented are discrete; their possible interrelationships in combinations of

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Shortly before the first article in this series ("Technology in the United States: Issues for the 1970s") was published in *Technology Review* for June, **J. Herbert Hollomon** was named to direct a new Center for the Study of Policy Alternatives in the M.I.T. School of Engineering. Since then the Center and the Charles S. Draper Laboratory Division of M.I.T. have been chosen to perform a $375,000 research project on how to improve the servicing, reliability, and maintenance of consumer durables. Dr. Hollomon, who was Assistant Secretary of Commerce under President Kennedy, studied physics and metallurgy at M.I.T.

To truly enhance our quality of life, we must make far wiser use of science and technology; and to do that we must learn how society chooses to use or abuse new knowledge. Though these questions are beset by uncertainties, their resolution can lead us to fresh opportunities and new values.

two or more have not been considered here, although they would have to be considered were they to be proposed as federal policy. Some options exclude others, some do not.

Option 1: Take No Specific New Actions

One policy option is to allow present trends to continue and to take no new policy actions aimed at making technology more effective in our society. A continuation of past policies will lead to continued and growing federal support for research and development as well as support for technical activities to improve the delivery of public services (such as health, education, and transport) and alleviate societal problems (such as crime). This kind of non-defense, non-space activity has grown during the past ten years at the rate of approximately 12 per cent per year, and we will assume a continuation of this growth for the future.

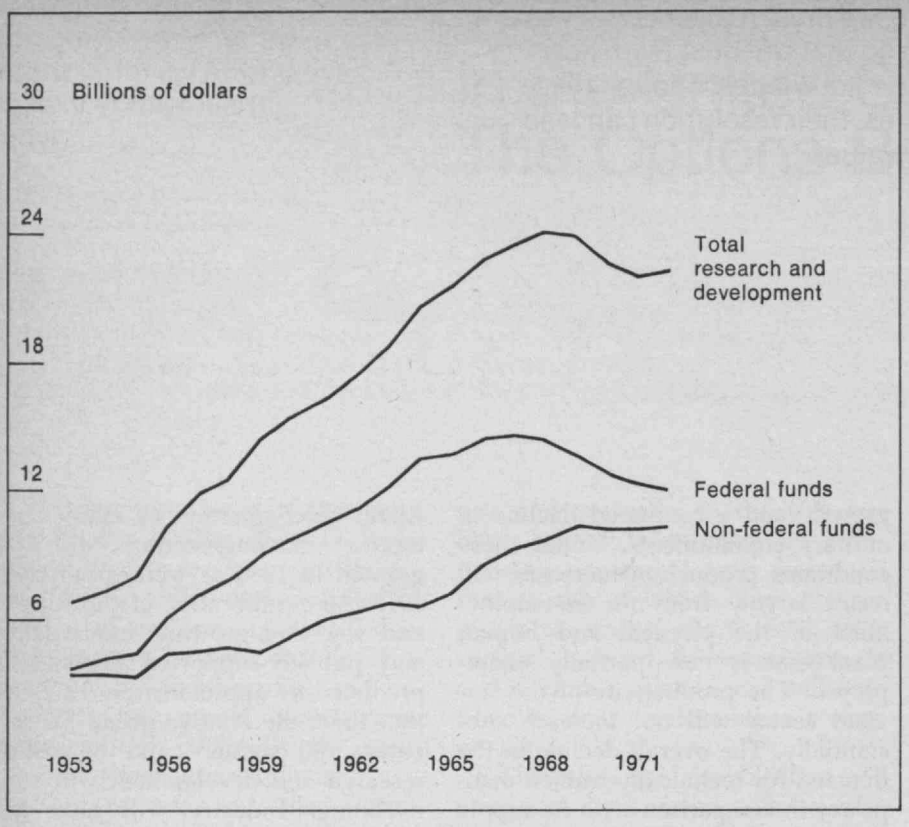
If we pursue the policies of the recent past, the relative decrease in research and development related to military activities will not occur as rapidly in the future as it has recently, and the percentage of G.N.P. devoted to research and development will level off at approximately 2.7. We assume then that the growth of industrial research and development as a fraction of G.N.P. will continue as it has for the last decade or two; no new conflict will generate new technical demands for hardware, and real per capita G.N.P. will grow approximately 2.5 per cent per year.

This set of assumptions obviously is based on a continuation of present policies that deal with the social consequences of technological change, a renewal of economic growth, and a continued decline in military commitments. Under these conditions production increases will result largely from the re-employment of the physical and human plant that is now partially unemployed. The productivity of the services sector will not increase substantially. The overall decline in the demand for technically trained manpower in comparison with its supply will continue for the next few years. As a result of excess supply, the prices paid for scientists and engineers will continue to fall relative to other wages and salaries. The number of college students who opt for the physical sciences and engineering will decline, eventually causing a decline in the supply.

Based upon the assumptions made about the national economy and using a supply/demand model for scientific manpower, Richard B. Freeman has predicted the number of trained people that will be produced in the future. His model predicts a substantial change in the supply of scientists and engineers in the late 1970s. Allan M. Cartter (who both vastly overestimates the supply and underestimates the demand) and others have also presented analyses of future trends in the supply and demand for scientists, but their analyses do not consider the delayed, yet significant, response of students to changing market conditions. The chart on page 35 illustrates the difference between the estimates made by extrapolated trends and those derived from the model incorporating market response mechanisms. Consideration of market phenomena leads to a prediction that one-quarter as many Ph.D. physicists will be produced in 1980 as are predicted by trend-extrapolation techniques. About three-quarters as many doctorates in engineering will be granted in 1980 as were granted in 1970. An equilibration of the supply and the then-growing industrially- and publicly-supported demand is predicted by approximately 1975. At that time, the relative prices for scientists and engineers and the cost of research and development will stop declining. Industry will have increased its commitment to all kinds of technical activities as a result of reduced costs. Although the supply of science and engineering graduates will be roughly equal to demand, a far smaller number will be graduating in 1975 than in 1970. Following 1980 the decrease in the college-age population in the United States may lessen the demand for scientifically and technically trained manpower in colleges and universities, but this will be partly offset by the growing demands in other sectors.

The positive consequence of this policy alternative would be an increase of 25 per cent to 30 per cent in the overall technical activity in the United States by the end of the 1970s. This increase, largely the result of the reduced cost of scientific and technical people, should lead in the long run to some improvement in productivity, in the supply of new products, and in the effective use of technical people to moderate the social consequences of technological change.

The negative aspect of this alternative would be its failure to decrease the current unemployment of scientists and engineers, resulting in an adjustment period of four to five years in which the potential contributions of unemployed, or underemployed, technical people would not be realized. The pool of scien-



Two changes have affected the pattern of U.S. research and development in the past two decades: the steady rise in total research and development investment (in constant dollars) which many scientists and engineers began to take for granted in the 1960s has in fact ended; and the proportion of our total national effort due to federal funds has declined. Do these trends, continuing into the future, augur an inadequate technological base for American industry? (Data in 1967 dollars: National Science Foundation)

tists and engineers would decline not only by attrition but because of the high obsolescence rate of their skills if not continually used.

Furthermore, this alternative would allow no *new* major commitments to pressing social problems, such as the improved delivery of services or the amelioration of the indirect effects of technology employed in the past. Neither would this alternative correct the underinvestment inherent in innovative activity by industry, nor would it create any additional activity aimed specifically at alleviating the growing disparity between foreign and U.S. technical capabilities in non-defense, non-space pursuits.

Option 2: Directly Support Private Technical Efforts

Economists have long known that in competitive free markets the single firm cannot capture all the benefits of its innovation, though it must bear the major costs. Furthermore, if the cost of the innovation is high compared with the financial capability of the firm, the risks, related either to possible failure in the market or to uncertainties about the success of developing the technology, may be too great for the firm to accept. There are also social and political obstacles to innovation related to the acceptance of new products or processes and the social and human adjustments that must occur as a result of the innovation.

In the last two decades the rising costs (salaries) of U.S. scientists and engineers documented previously have so raised the costs of innovative activity in private industry as to considerably deter it. The inflated salaries and the decrease in the growth of technical activity may have been a factor in the decreasing rate of productivity increases in the private sector; productivity increases in the period 1966-71 were about half that per unit input of the preceding two decades. Inflated salaries certainly contributed to the current situation in which Japan can employ two to three times as many scientists and engineers as the United States for an equivalent expenditure and, therefore, can effect technological innovations at lower relative costs than the United States while taking advantage of U.S. technology through the purchase of patent rights and know-how.

All these factors suggest a national policy and program that would reduce the costs to the private sector of invention, innovation, and diffusion of technology. Whether the private sector produces the goods and services that best benefit society can be viewed as a separate question. Separate policies can create incentives and disincentives to alter the direction of industrial activity. The latter can be achieved through such means as pollution controls or the creation of a market for new public services; but whatever the direction of industrial activity and the social, political, or economic goals, the processes of invention, innovation, and the diffusion of technology must accompany them.

One mechanism that would reduce the costs of innovation to the private sector is a direct subsidy or tax credit for industrial research and development. A 35 per cent subsidy of industry's research and development costs would simply return the costs of technical activities relative to other costs to the level at which they existed prior to the major distortion introduced by the large federal research and development involvement of the 1950s and 1960s. Since all technical salaries have been inflated and since research and development is only one of the modes of innovative change, this size of subsidy of a firm's total technical effort could theoretically be justified. Obviously, the subsidy would stimulate the demand for scientists and engineers and maintain the high prices now paid to them. Indeed, the fact that the benefits of innovation are not fully appropriable might argue for the maintenance of a small subsidy for all innovative technical work; however, this is probably politically impractical.

Such a subsidy could be provided, either for all research and development investments made by a firm or for incremental research and development investments above a certain historically determined base. The latter proposal more reasonably meets the argument that research and development now supported by firms is economically justified and should not be subsidized. It has the advantage of leaving investment decisions closely coupled with market conditions and tends to correct the

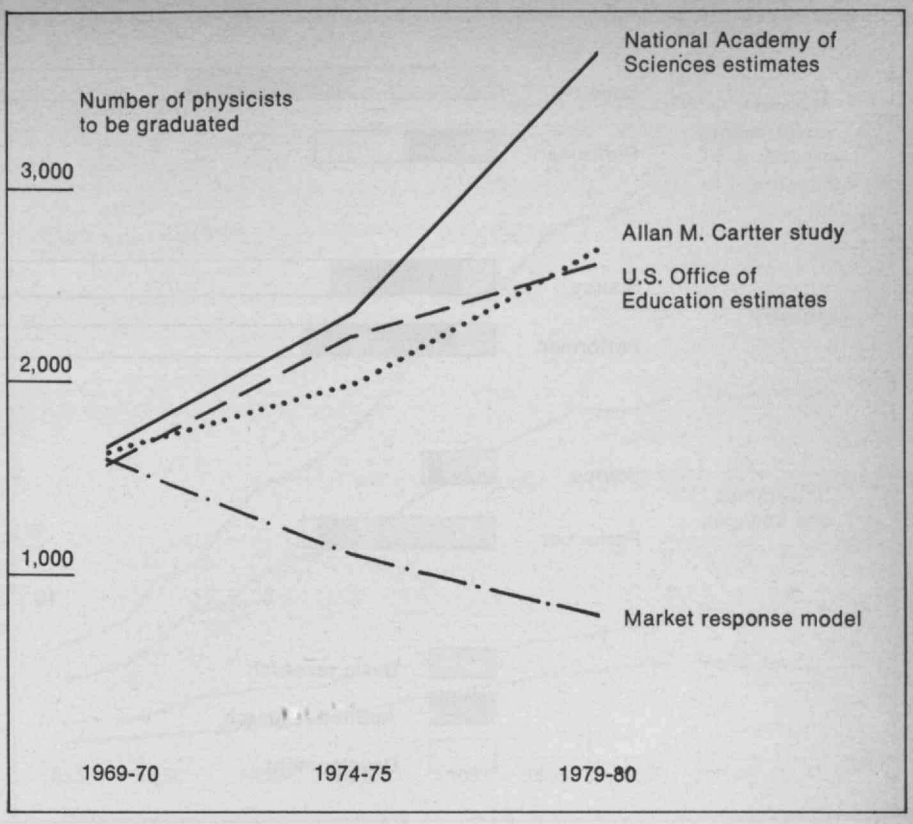
inflation of costs now present in the entire industrial system with respect to technology. However, the size of the subsidy must be carefully considered. Too large a subsidy would encourage high salaries as it increases employment.

Audits and Controls

The arguments against such tax credits center on anticipated administrative difficulties rather than on questions of economic principle. Any subsidy would encourage individual firms to call many industrial activities research and development in order to reduce costs and increase profitability. This difficulty might be overcome by recognizing that increased research and development must be accomplished by employing more scientists and engineers, an action which certainly could be subject to audit. In addition, data collected by the Bureau of Census and the National Science Foundation indicating long-term trends could serve as a basis for judging whether increases in research and development were in fact stimulated by the tax subsidy. Since about 90 per cent of all research and development in industry is conducted in 300 large firms, the policy of tax credits would not seem impossible to implement, although one function of the tax credit would be to encourage smaller firms to engage in research and development.

Some argue, too, that the tax system should be concerned only with collecting revenues and not with correcting difficulties inherent in the economy. Others argue ideologically that federal subsidies should be based on political judgments of what is "good" for the society, that the issue should not be left to forces of the market and public regulation. It is clear that a tax subsidy will not necessarily encourage investments in those activities that deal with the broad social needs of the society. These needs will have to be supported directly or stimulated separately in private industry by imposing specific incentives or disincentives. This argument implies that the policies for encouraging the *processes* of technological change can and should be separated from the policies affecting the *purposes* to which the processes are applied.

Innovative industrial activity can be stimulated by other means as well. The technical base—i.e., the state of the art—on which technological innovation takes place in industry could be, as it is now in part, supported directly by government. Two activities basic to improving industrial output are the development of the production process, which involves automation, management, and the design of production equipment; and the development of design methods and techniques for new products. These activities could be supported directly in technical schools and universities as investments in the technical base of the society and as a way to influence the training of young scientists and engineers toward concern for industrial problems. This support would be similar to that now provided by the defense and space agencies which, to encourage the advance of certain technologies, subsidize research and the training of people within specialties basic to their missions.

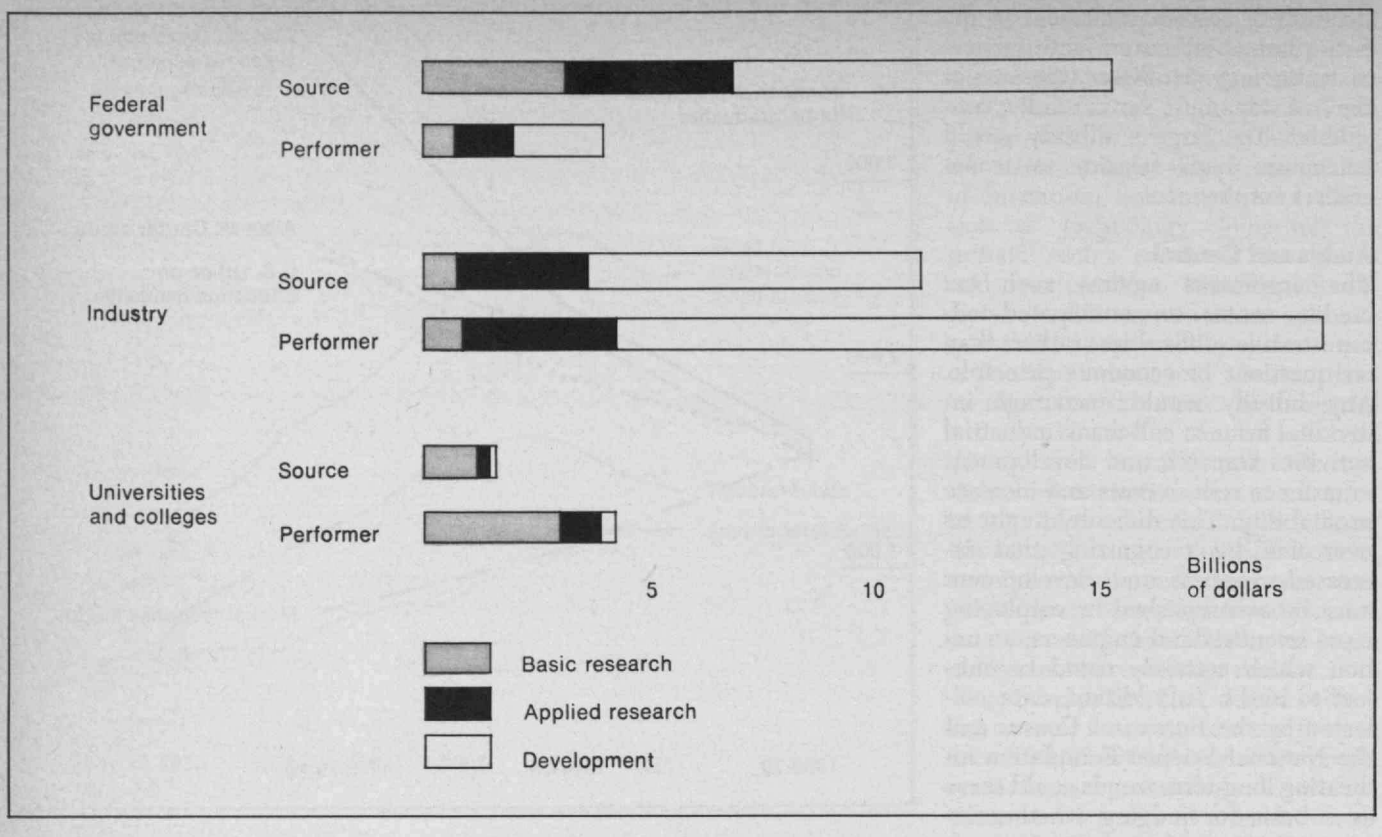


Though estimates of the supply of new Ph.D. graduates in physics based on extrapolating current trends differ widely, they all differ even more markedly from estimates made with a model which incorporates market response mechanisms. In other words, we often fail to realize how sensitive are the career plans of college students to their perceptions of future needs and rewards in any particular profession or field.

Support for Basic Science and Engineering

There has been little question that certain scientific and technical efforts were necessary to develop the resources subsequently used in the space and defense effort. Analogously, it might be desirable to provide support for the non-appropriable work required to sustain the technology and science underlying industrial innovation. This support, primarily through grants to universities, would reduce the technical risks of innovation and would provide new, effective couplings between universities and industry. Perhaps grants to universities might be restricted to those cases that offer some assurance of industrial cooperation, possibly through associations or through matching grants by industry. The potential effectiveness of this mechanism can be supported by studies of defense-related innovations, which clearly indicate that a disproportionate number of the individuals involved in defense innovation came from those schools that received large amounts of defense research support.

One way to estimate the relative size of such a support program would be by considering the ratio of support given universities by de-



Already American industry performs far more research and development than it pays for, as a result of federal contracts to industrial laboratories. But much of this work is on matters of little industrial relevance, so it may be argued that federal inputs to these laboratories provide competition—rather than support—for the innovation that American industry now needs. (1972 data: National Science Foundation)

fense and space agencies to the agencies' total research and development activities. This ratio was 3.4 per cent for defense and 3.3 per cent for space in 1969. Since the total of industrially-supported research and development is roughly $12 billion, the level of support given universities might be on the order of $400 million. To best connect university activities with industrial needs, it might be desirable to establish a program in which both government and industry participate.

Basic civilian science and technology might also be encouraged by establishing a series of government- and industry-supported research institutes coupled to universities. These would be similar to the Max Planck Institutes in West Germany, which were largely responsible for the great scientific strength of Germany in the early part of this century and appear to be a significant means for closely coupling university science and industrial technology in West Germany today. While Great Britain's public support for industrial research associations has been criticized, the United States might explore the underlying idea of connecting the universities to associative activities. Most industrialized countries other than the United States have used this mechanism to achieve the diffusion of technology; the United States might find this kind of association an effective mechanism for improving the capability of the vast majority of small firms that cannot afford to perform their own research and development.

Option 3: Indirectly Support Private Technical Efforts

As indicated previously, industrial innovation appears to be most successfully encouraged by the "pull" of market demand. New agglomerations of markets and increased demand encourage investments in research and development by reducing market risk, while declines in demand often retard investment in technology. There is little doubt that the low investment in technology in such U.S. industries as shoes and textiles is related to their relatively slow growth. Other factors that characterize a conservative, change-resistant enterprise are probably involved in the construction industry's failure to capitalize on research and development: restrictive labor practices, product codes, and standards aimed at protecting vested interests.

It is also true that—particularly in housing—firms are often small and unable to undertake the high-risk technical activities required to bring about rapid product improvement or significant efficiencies. Ezra Ehrenkrantz has demonstrated that when the individual requirements for a number of new school buildings in California were consolidated into a single performance specification, industry responded with innovative ideas that permitted the construction of more efficient buildings.

Textile and shoe manufacturers could apply this lesson by agreeing to set performance standards for radical new machinery; without such radical technological change, these industries may be unable to compete with foreign firms paying significantly lower wages. With encouragement by federal subsidy, research and development might be stimulated by the prospect of a new, large

market for shoe and textile equipment. Increased domestic production of advanced machinery would have the additional effect of reducing the present importation of machinery and might even stimulate an export market. As a large purchaser of civilian goods, the federal government could agree on performance specifications that require industrial innovation and pay for the prototype development to reduce both market and technical risks to suppliers. A program of this type was initiated several years ago by the General Services Administration for the development of government administrative buildings and could be extended to food products, clothing, medicinals, and any goods the government buys in large quantities.

Techniques developed as a result of this mechanism should be directly applicable to the production of goods for the civilian market. Evidence of the effectiveness of this technique of "pulling" technology has been established by computers, airplanes, and integrated circuits produced originally for the federal government that now have extensive commercial markets. The federal government could extend this mechanism by requiring, for example, that hospitals receiving federal support be constructed through cooperative efforts that set performance standards for successive buildings.

Other indirect means exist for encouraging technical development in firms or industries with little knowledge of modern techniques. A novel notion now being tried in Canada is to support the education of graduate students partly through direct grants and require them to work in industry for the remaining support for their graduate activity. Such a program might stimulate the industries themselves to support other people. Students, in turn, would be stimulated to be knowledgeable about the problems of the industry supporting their education. Government could receive benefits similar to industry by initiating apprentice programs within government agencies.

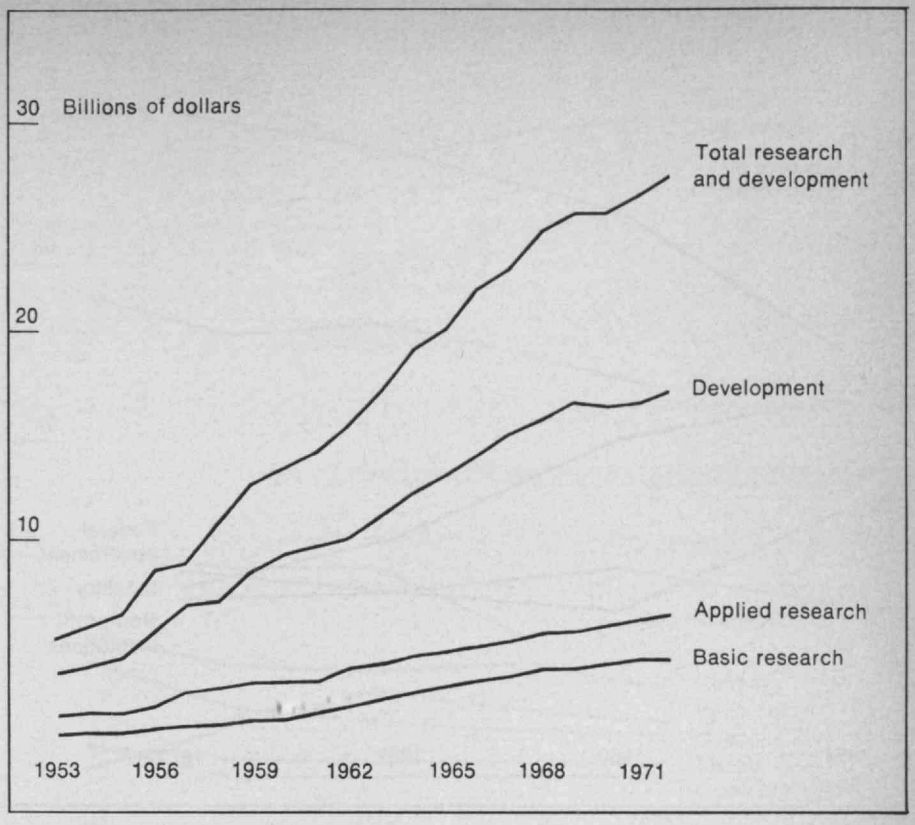
Option 4: Improve the Services Sector

With half of our workers engaged in providing services, the United States has become the first post-industrial society. The fastest growing services are health, education, and local and state governments. These services are provided by a large number of diverse establishments, few of which are able to support the technical efforts necessary to improve their efficiency or effectiveness. The fire-fighting, police, welfare, road building, and sanitation activities of local governments, for example, have not benefited significantly from advances in technology.

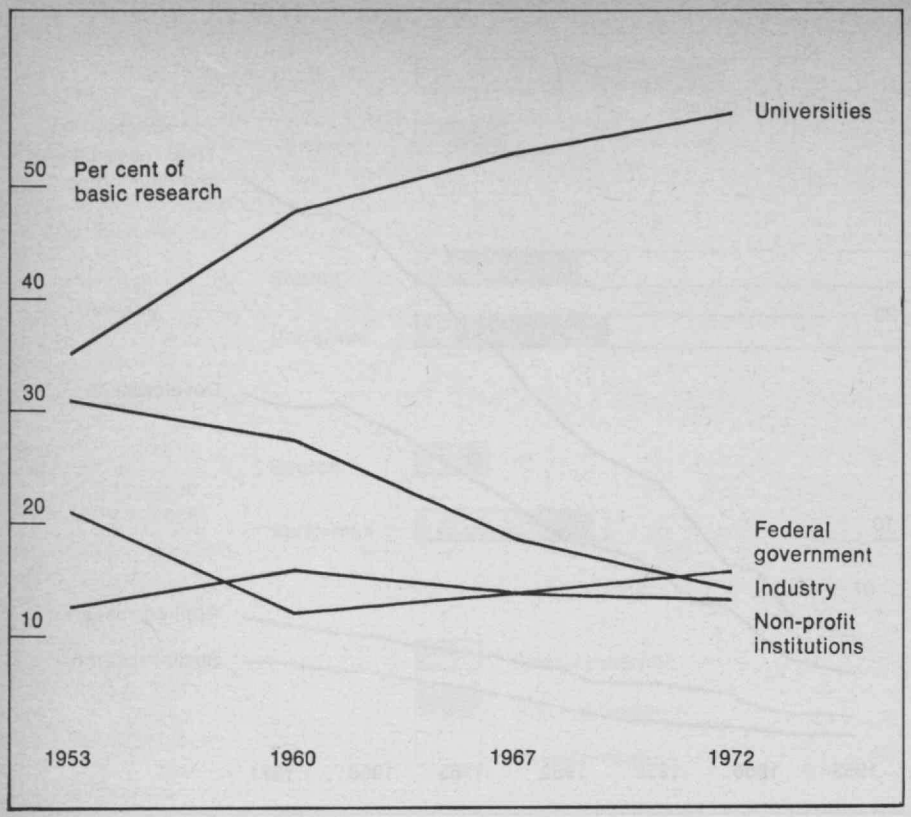
The services sector might be likened to highly fragmented industries; but lacking the discipline of a profit motive. Technological innovation is discouraged in the institutions that supply education and health services, for example, by their structures and incentive systems which inherently discourage cost-reducing changes. In these institutions, the individuals who determine the system's operating characteristics and level of effectiveness—for example, doctors and teachers—do not have much incentive to reduce costs. Indeed, they often find it convenient to increase delivery costs, since they are not forced to bear any of them directly.

Yet there are technologies basic to each of the several components of the services sector which could, if used, improve the effectiveness of the services they supply. Community health plans that associate medical facilities with treatment and provide financial incentives to reduce health care costs may be one way of restructuring the health delivery system to encourage innovation and improved service. Although no equivalent scheme for improving either schooling or government services has yet been tested, the soaring costs of services and decreased growth in demand for them will begin to induce a climate for innovation to improve their effectiveness and efficiency.

Improvements in government, health, and education services involve invention, innovation, and diffusion as do the other sectors of the economy. These processes must be supported either directly by the government or by individual institutions under incentives to support the innovative process themselves. Currently, the percentage of research and development allocated to improve public services is small com-



What should be a rational balance between basic research, applied research, and development, in a total national research and development program? Though there is no certain answer, the balance has not significantly changed in the past two decades in the U.S., despite considerable change in priorities and in the technologies to which research and development is devoted. (Data: National Science Foundation)



Universities have been the traditional sources of basic research in the U.S., but since most of this work has been financed by federal funds it is reasonable to question how much of it has been significant as a source of new industrial technology. The author suggests a basic research program funded jointly by industry and government. (Data: National Science Foundation)

pared with the total costs of providing those services. Correlations between productivity improvements and research and development in industry may serve as a basis for estimating the amount of research and development that could be justified for health and education services. Growing and profitable industries devote at least 4 per cent of their sales revenue to research and development. A level that is 3 per cent of the total health and education services expenditure would require a public research and development investment of $5 billion. It must be remembered, however, that no amount of research and development, invention, or even preliminary innovation is sufficient to ensure that changes will be adopted broadly and diffused throughout the services sector; the institutions themselves must accept the changes that are devised.

As in manufacturing, there are techniques connected with the storage, manipulation, recovery, and analysis of information that are basic to each of the components of the services sector: in education, the science and technology of learning and teaching; in health care delivery, the technologies associated with testing, diagnosis, and prevention of sickness (rather than the cure of disease); in government, the application of operational analysis and control procedures to such activities as fire-fighting and the allocation of police resources have already been demonstrated. These techniques could be developed for the services sector by the universities with the support of research and development and the encouragement of cooperative arrangements.

In addition to the services of government, health, and education, there are services connected with industrial products; these, too, are costly and growing. The repair, maintenance, and disposal costs of durable consumer goods are high and increasing. Here, too, incentives to design more reliable and longer-lasting products are possible—not only to reduce repair costs, the consumption of raw materials, and the pollution generated in manufacturing, but possibly to create new markets. The federal government could, for instance, purchase radically new products and require that they be maintained and disposed of by the producer. This method has the net effect of making the producer actually provide the *service* that the product is to render —reliably, and over an extended and definitive period of time. Considerable technology already has been developed for the military and space programs that could be used in the design of more durable consumer products. Currently, however, the producer and original buyer are concerned primarily with the initial product performance and have no way to adequately anticipate future repair, maintenance, and public disposal costs. Encouraging the sale of a consumer service rather than a consumer durable might provide a better way to produce goods at reduced total cost to individuals and to society.

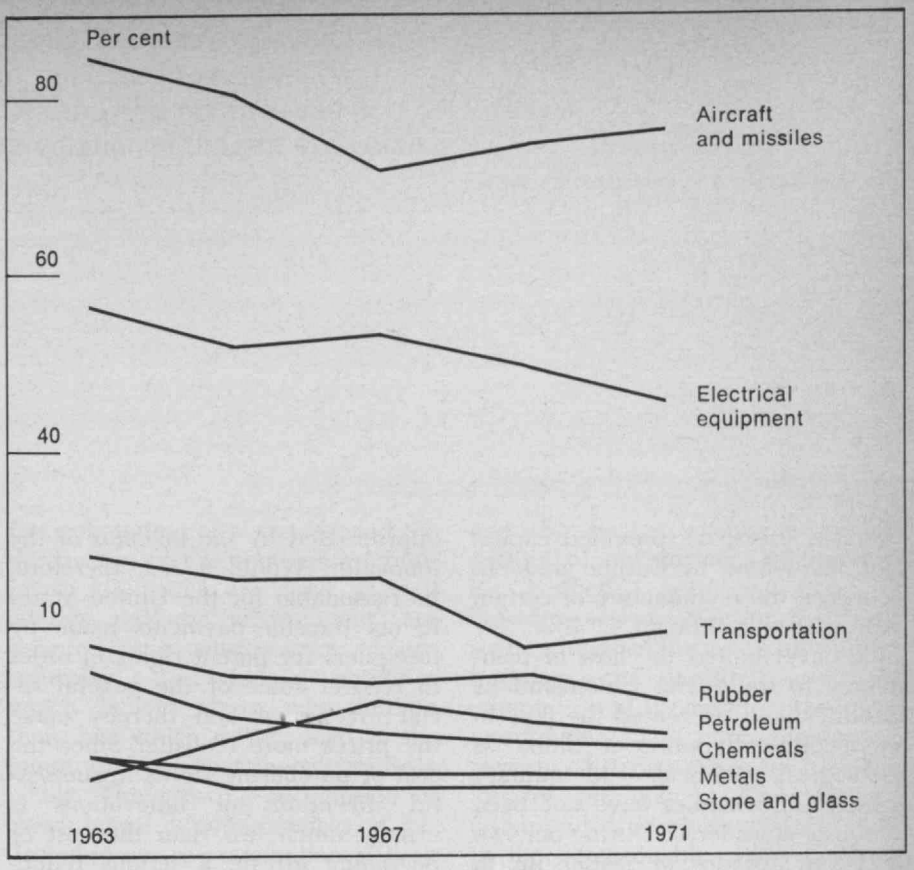
Option 5: Support Training and Relocation of Displaced Workers

Workers are displaced and sometimes the economies of whole regions are depressed as a consequence of technological change. While there is no evidence that technology reduces employment in the long run or in the aggregate, change obviously causes local and often severe individual and social dislocations: workers with particular skills are displaced and may not find other employment; regions and cities, like Appalachia or Seattle, become economically depressed. The costs of the technical change are borne by the small number of people affected, while the benefits of the change flow to the society as a whole. Growth industries do have some incentives to retrain and relocate their workers as they expand to serve new markets and reduce their overall costs. However, in slowly growing industries, where the total number of jobs in the industry may be declining, displacements are particularly costly. The mere threat of displacement, as well as displacement itself, slows the innovative process and reduces further the competitiveness and growth of these industries. The textile, shoe, and fisheries industries in the United States are likely examples of this phenomenon.

Publicly supported retraining and relocation programs reduce the inequities induced by technological change and stimulate the overall process of change. There are today

a number of such programs, some supported publicly and some privately. However, a more broadly based program paralleling those established in Sweden, West Germany, and—recently—France could be highly effective in the United States. France's imaginative new program, which might be called "educational welfare," requires the worker and his employer to contribute to an educational fund vested with the employee. The accumulated fund, after a certain initial period, may be used by the worker for training or education that improves his skills or makes him more adaptive to a new job. Such a fund, which could also be used to pay relocation costs to another region where jobs are more plentiful, encourages adult education and retraining; and the firm, and society, and the worker all share in the cost of retraining as they share in its benefits.

Even excluding such a scheme, a major review and overhaul of present training and relocation programs in the United States seem desirable. The legislation now under consideration that benefits only particular classes of workers, such as displaced scientists and engineers, does not seem equitable. Since the consequences of changes in public policy or technology affect many workers, an equitable program would be one that treats all workers alike and allocates the costs between worker, employer, and the public at large.



The federal contribution to U.S. research and development varies widely among industries; this chart shows the proportion of all research and development scientists in various industries who were supported by federal funds during the past decade. Should a larger federal commitment be made to U.S. industries where innovation seems to be faltering and foreign competition most sucessful? (Data: National Science Foundation)

Option 6: Support High-Risk Ventures

A number of studies indicate that a disproportionately large number of major inventions and innovations come from private inventors and small, innovative firms—especially research and development firms. The private inventor and the small firm alike face the extraordinarily difficult task of obtaining early development support for ideas that have not yet proven to be feasible technically or to lead to saleable products. While the individual inventor or new firm must bear or find support for initial costs, the costs of inventive and innovative activity in large and profitable firms can be treated as an expense within the present tax structure; such costs are deductible as future benefit costs, and, in a sense, are partially supported by a reduction in the taxes of the firm. No similar tax benefit flows to the private inventor or the fledgling firm not yet in business; however, there are some loss-carry-forward benefits if the firm "survives," and these could be extended. As suggested earlier, there are arguments to support a tax reduction for incremental research and development, but such a tax reduction would benefit only existing large firms. Yet large firms with large technical and marketing organizations and complex plants often are unwilling to invest in inventions or innovations that are new to their business or that may not be directly applicable to them. The establishment of a negative income tax for the first few years of a new firm's life, however, would give a benefit to the new firm analogous to the tax reduction on research and development for established firms.

A publicly supported organization that provided high-risk, early support to private inventors or small firms in exchange for a share of the equity would also help bring new concepts to the stage where the enterprise system could more readily evaluate the technical and market risks. The judgment for support and the amount of equity should be based on an assessment of opportunity for each case. Over the long run, it is likely that an institution that supported very high early risks could be self-supporting. Because an inventor or entrepreneur usually needs advice concerning the availability of venture capital, business techniques, and marketing, the organization that furnishes the early-risk capital could also arrange to have business schools, which use faculty and others with practical, entrepreneurial experience, provide this expertise.

Option 7: Improve the Transfer of Technology

During the post-war reconstruction of Europe and Japan, the United States had little incentive to seek out new technological developments from abroad or to be concerned about the patent rights and know-how obtained from foreign firms. Indeed, the flow of innovation was presumed to be from the U.S. to

overseas users; we provided capital and know-how to Europe and encouraged the manufacture of certain military goods in Japan.

We have limited the flow of technology to the Soviet Union and its satellites, and prevented the flow to the People's Republic of China on ideological, political, and military grounds. Economics have not been seriously considered. During our two post-war decades of leadership in science and technology, particularly in space and defense, we became convinced of our scientific and technological superiority and even stimulated the Europeans—especially the French—to be concerned with an irreducible "technological gap"—a hue and cry which in recent years seems to have been muted.

Now the situation is quite different. The negative as well as the positive consequences of our past federally supported programs are more evident and more carefully considered. We are beginning to understand the consequences of our failure to recognize the need for public policies and programs to improve productivity and to ameliorate the systemic and deleterious consequences of our system of production and consumption. Any flow of technology between nations, like any flow of trade, is generally conceded to be beneficial in the long term. But how foreign technology should be paid for and what are the best means for making more available the technological knowledge developed abroad remains unclear. The United States still has a large balance of payments in its favor for the purchase of patent rights and know-how. The original developments that led to this favorable balance were based on the state of the art and on technical activity supported by the general public and appropriated by the inventor or the innovator. Would it not, therefore, be reasonable for the United States to tax transfer payments made by foreigners for patent rights in order to recover some of the general social investment and thereby make the prices more realistic? Since the cost of purchasing rights to successful inventions or innovations is usually much less than the cost of beginning afresh, a serious reduction in foreign acquisitions is unlikely if such a policy were implemented. Even if there were a reduction, would not the result be equitable and reduce some of the relative foreign advantage?

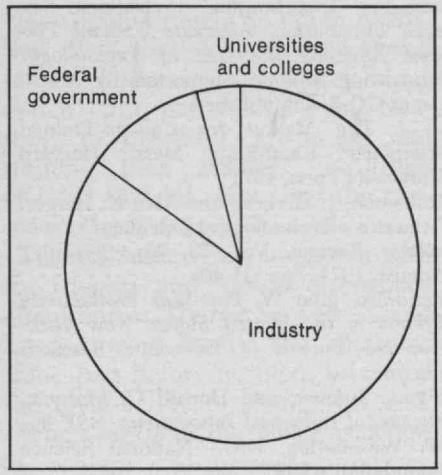
United-States-based multinational firms internally transfer know-how and also provide training and experience for foreign workers. Through the establishment of foreign branches, a United States firm may be able to enter markets not otherwise open to it and create a demand for U.S. exports that support the foreign production. Furthermore, these firms are able to obtain foreign technology from their overseas operations for use in the United States. Even so, there is the question of the extent to which these firms should enjoy special privileges of "free" transfer of U.S.-developed technology (as differentiated from science) or enjoy special tax benefits. The possibilities and consequences of taxing income earned abroad at the time it is earned, rather than when it is repatriated, might be examined.

Since the late 1940s the United States has subsidized the travel of many foreign nationals visiting and studying here. We should now capitalize on this program to develop new means for obtaining knowledge of the new applied science and technology developed abroad. Industrial associations could be supported to establish information centers abroad. Foreign travel and stipends for extended visits of United States scientists and engineers abroad could be augmented.

The "science attachés" in our embassies abroad have heretofore been concerned primarily with the exchange of scientists and scientific information and with cooperative efforts related to national programs of defense, space, atomic energy, and health. A similar and substantially greater effort to assist in obtaining technology affecting industrial productivity and environmental effects would now appear to be justified. Though only a small number of people would serve in this role, they might act as catalysts to aid in changing the view of U.S. firms and technicians toward the greater exploitation of techniques developed abroad. Like other countries, the United States must choose the fields in which it will concentrate its technical resources, and buy technology wherever possible. In the future, unlike the past, there will be many fields in which one nation or another leads the United States—and we must adjust to this new circumstance.

Through its years of technological leadership, U.S. engineers have developed a "not-invented-here" complex. They don't believe they have anything to learn from foreigners. They would rather reinvent than learn from others. The contrast with attitudes of Japanese engineers is especially striking. The Japanese are prepared to take the best from anywhere and really learn it thoroughly to the point where they can improve on it.

It is in a time of change and uncertainty that fresh opportunities arise. If we are to benefit from them, our technology must be increasingly responsive to new values and new norms—and it must be developed with a fuller appreciation of the self in all of us.



At least 85 per cent of U.S. development work—in contrast to basic and applied research—is being performed in industrial laboratories in 1972. Leading industries in terms of development are aircraft and electrical equipment and communication (both heavily involved in federal work) and machinery, automobile, and chemicals (where the federal commitment is much less). (Data: National Science Foundation)

Option 8: Ameliorate the Consequences of Technological Change

We know that a number of major social and environmental problems have arisen as a result of the widespread use of technology and the concurrent changes in the social, physical, and political environments. Serious questions have been raised about the stability of our growing and changing system, about the relationship between private benefits and social costs of technology, and about the ethics and values basic to our society.

The Renaissance, the Reformation, the Scientific Enlightenment, and the Industrial Revolution brought into being institutions and values that encourage individual success, the exploitation of resources, and the destruction of the common environment. Air, water, and land, as well as our aesthetic environment, are polluted as a consequence of uncontrolled individual activities which benefit those who initiate them but which do not lead to the long-term benefit of the society as a whole. The growing recognition of these harmful consequences is reflected in our re-examination of both the institutions and the norms of society—i.e., the literature of dissent.

In principle, the long-range consequences of physical pollution can be estimated by comparing the direct benefits and costs of continuing growth within the existing framework of society with the benefits and costs of technological change. True, the methods of measuring some forms of pollution are unavailable, the consequences unknown, and the possible mechanisms for correction undeveloped; but the basic issue is one of determining the limits of permissible pollution and applying incentives or disincentives to motivate the society to reach those levels.

Three types of activity are required to curb pollution. First, we must determine the harmful side-effects of various contaminants and develop methods of measurement. Second, we must determine permissible pollution levels and the social and economic mechanisms needed to achieve them. Third, we must learn the technology of contaminant reduction, how to substitute new means of production, or how to make products that are less polluting.

There are some who question whether the present economic and political systems can be patched to ameliorate even the physical consequences of technological change and the further economic growth pattern of our society. In the case of aesthetic pollution—such as crowding, devastation of the landscape, ugly billboards, and uglier buildings—the questions are more ethereal and, consequently, less quantifiable. The consequences of psychic distress expressed in the loss of production and increased crime and drug abuse are also only partly determinable. Indeed, these issues of aesthetic and psychic disturbances are more philosophic and religious, related to the deepest values of individuals in the society and of the institutions which they construct.

All of these distressing consequences are interrelated in ways that are little understood. Even so, there now exist activities that might with more public support contribute to the amelioration of the growing contamination of our environment and the destruction of our commonly held resources.

Until very recently almost all government programs associated with non-space, non-defense technology have been aimed at producing new goods and services without much consideration of the indirect consequences of their introduction into the society. For example, we know almost nothing about the total indirect costs of automotive transport; not only do combustion engines pollute, but automobiles lead to congestion and high traffic volume and parking costs in the central city. Determining the external or social costs of industrial processes and products is essential if we are to devise optimum ways of reducing these costs.

Nearly all of the present federal support programs aimed at meeting the energy crisis are devoted to im-

proving the efficiency of or reducing the pollution in the generation and transmission of energy; almost none of the analysis, research and development that might lead to reducing the use of energy is being supported. Because direct energy costs are so low and because energy users are so diverse and diffuse, few incentives exist for technical programs to improve the effectiveness of the use of energy and thereby reduce the waste inherent in the energy production and use system.

As we determine social and external costs and ways of reducing the use of commonly held resources, the industrial system of the United States must be modified to reduce these costs and the destruction of common resources. The changes necessary to the system will sometimes act against the immediate self-interest of those affected and will surely be resisted. Social research and experimentation are necessary to determine those incentives and disincentives which balance long-term interest with the short run.

Changes that ameliorate contamination or reduce the exploitation of natural resources will be introduced by the same processes of invention, innovation, and diffusion as other technical changes. A highly sophisticated base of technical knowledge and appropriately trained people will be required to use this knowledge effectively. Though a great technical effort will be required to quantify the social costs of pollution and set standards that will reasonably balance costs and benefits, the change we need will be effected mostly by "pull" mechanisms. Support will be required for high-risk ventures, for reducing the risks of innovation, and for assuring the widespread diffusion of newly developed techniques.

National programs were initiated in the 19th century to encourage invention, innovation, and diffusion of technology to and for the American farmer. Activities of a similar scope seem necessary now to support the efficient use of products and services by highly fragmented consumers. Just as mining technology has been supported by the federal government for nearly two centuries, we might now develop an equivalent program aimed at recycling waste and reducing the consumption of natural raw material. Methods of monitoring environmental pollution and measuring its effects have begun to receive attention—but not sufficient to change the present pattern of growth. Additional schemes similar to those now being implemented for pollution controls for automobiles are needed to provide incentives for industry to invest in technological developments in the long-term interest of the society: programs for new institutional arrangements, for increased support of new subjects in universities, and for freeing those able to apply these subjects to the major social problems we face. The present apparatus of government, often designed to encourage and develop the interests of special groups, is ill-suited to carry forward such a major shift in national priorities or technical activities. There is, for example, no overall authoritative agency in government dealing with science and technology that can estimate and ameliorate the short- and long-range consequences of their application to the society. The often-suggested creation of a cabinet-level department for science and technology should be thoroughly considered.

Epilogue

We began with consideration of a changing world that requires new initiatives that might contribute to the continued growth and well-being of the United States. By growth we mean the growing improvement of the quality of life and the establishment of conditions leading to the preservation of that quality in the future. The effort and changes required will be large. We will need more skilled people and greater investments in science and technology. We will need a far greater knowledge of the processes by which invention, innovation, and diffusion occur, particularly in a society in which the free, individual enterprise system has to be altered so as to more automatically preserve the commonweal.

We do not sufficiently understand the mechanisms involved to be certain either of the consequences of our present patterns of growth or the best ways of changing them. We therefore require deeper knowledge of the functioning of our society and of the potential collective effects of individual actions. We have emphasized that technology and science, if we are to survive, require a growing appreciation of new values and new norms and a fuller appreciation of the self in all of us. It is in a time of change and uncertainty that fresh opportunities arise.

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Engineering Social Systems

Systems engineers are familiar with inverse feedback and boilermakers with "blow down," but these simple ideas are seldom brought into the realm of social and political decisionmaking. Here are some examples of how they may be used to enhance our understanding

Once upon a time a Sultan in Arabia had two sons who greatly loved horses. Both sons spent their time, and a large part of the royal treasury, in breeding, grooming, and training their stables; and each claimed that his stable had the fastest and best horse in the world.

The old Sultan grew impatient with the frivolity and endless discussions about horses. He felt his sons should learn how to handle the affairs of state. Just before he died, he called the royal scribe to change his will.

When he died, the will was found to contain an unusual provision. Each of his two sons was to select the best horse from his stable and to race those two horses to Mecca. The Sultan's shiekdom would go to the son whose horse finished last.

All was done as he wished. The two sons started to Mecca astride their fastest mounts albeit at a leisurely pace. They stopped a week later at an oasis about ten miles out of town—wondering if their father had condemned them to a life of wandering in the desert. They sought advice from a wise man who had stopped at the same oasis.

They never thanked him for his suggestion, for once it was made the sons ran for the horses, mounted, and rode off towards Mecca at full gallop.

What did the wise man say?

An Old and General Principle

The wise man said, "Why not swap horses?" Each son ran to mount his brother's horse to reach Mecca first so that his own horse would finish last.

The wise man's approach represents an engineering principle called "inverse feedback." Part of the output of a system is used to reduce the input to that system or to increase the input to a competitive system. Here, such a system of horse and human was altered so that the control part of one system increased the output of the working part of the other. Each son had to decide how long and how hard to ride his brother's horse lest the animal collapse and lose the race.

One engineering application of the inverse feedback principle occurs in electric power generation. The normal generator has an extra set of windings connected so that as the demand on the generator grows, its output voltage rises to compensate for higher transmission losses. This is positive feedback, for the greater the load, the higher the voltage, which makes the load appear still greater.

This works well with one generator but, as Thomas Edison found out, not at all with two. His first commercial generating plant had two generators. When he turned the system on, one generator slowed down and the other speeded up. The movie "Edison, the Man" showed Spencer Tracy as Edison trying to turn valves and throw switches fast enough to control the system.

One of the "identical" generators in the system was, because of slight differences in manufacture, more efficient than the other. As a result, the efficient generator picked up more of the load than the other. The positive feedback in its design caused it to thus increase its voltage and output, and the second generator was forced to drop some load. Soon the first generator was overloaded and slowed down; the unloaded generator then speeded up and began to run away. Edison tried to shift the load manually from one to the other, but the system always responded by shifting more and more load itself. With positive feedback, the system was unstable.

Mr. Edison was a practical man—and in this case without finesse. He installed some large gears and a heavy shaft that forced the generators to turn at the same speed. The system was set in operation in time to preserve Mr. Edison's power company franchise, but his solution was inefficient, complex, and inflexible.

Perhaps Mr. Edison had not heard of the Sultan's riddle, for the accepted solution is the same: to exchange horses, to use inverse feedback. The extra windings on one generator should derive their power from the output of the other. If the first generator picks up more load, it signals the other to take a larger share. The system is perfectly balanced and stable. Neither generator can drop its load at the expense of the other. (The scheme works just as well with three or more generators if the windings on A derive their power from B, those on B from C, and those on C from A. No matter how many sons the Sultan has, the wise man's solution will work if no son rides his own horse.)

To Yield a Truer Control

Positive feedback has another serious drawback besides instability that limits its usefulness: it lacks fidelity. As an example, consider electronic amplification.

Electronic amplifiers such as in a radio or television set sometimes use positive feedback: some of the out-

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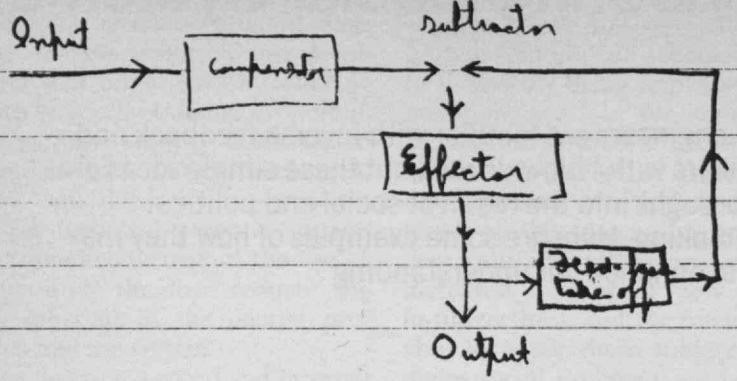
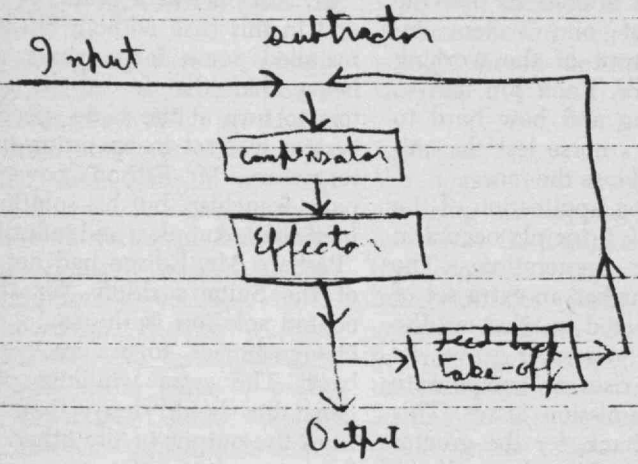


In this, the entire feed-back system may be regarded as a larger effector, and no new point arises, except that the compensator must be arranged to compensate what is in some sense the average characteristic of the feed-back system. Another type of arrangement is the following:



Here the compensator and effector are combined into one larger effector. This change will in general alter the maximum feed-back admissible, and it is not easy to see how it can ordinarily be made to increase that level to an important extent. On the other hand, for the same feed-back level, it will most definitely improve the performance of the system. If, for example, the effector has an essentially lagging characteristic, the compensator will be an anticipator or predictor, designed for its statistical ensemble of inputs.

put is fed back to increase the input signal. A very small input signal is amplified, a portion of the output is fed back and amplified again, and a portion of this is again fed back—and on and on. The amount of amplification can be enormous.

Any amplifier generates some distortion, and it is included in the portion of the output used for feedback. As the distortion is fed back and amplified many times over, it becomes relatively more important. Thus a positive feedback system gives high gain and high distortion.

If we want fidelity of amplification, we achieve it better by using inverse feedback. Instead of feeding some of the output back to reinforce the input signal, we use it to cancel some of the input signal. This is self-defeating—it reduces the gain of the system; but it is especially defeating to internally generated distortion. Any internally generated distortion creates an input signal counter to that distortion. To wipe distortion out entirely would be to wipe out the entire output signal, but inverse feedback will foster more faithful amplification.

If we want maximum gain at the expense of fidelity and stability, we use positive feedback. If we want stability and fidelity at the expense of gain, we use inverse feedback.

The usefulness of the concepts of feedback for understanding human as well as mechanical behavior were explored by the late Norbert Wiener in his pioneering work on *Cybernetics* published in 1948, just as the author of this article was completing his undergraduate work at M.I.T. The original manuscript of Professor Wiener's classic study is now in the M.I.T. Archives; this page from it reveals one phase of the author's exploration of feedback principles.

Inverse Feedback: A Social Tool

Now that we see what inverse feedback does in engineering applications, let us see if we can apply it to two social systems. In each instance, we will see that positive feedback is present and that it produces the results our engineering background would predict. I will postulate that negative feedback might be more beneficial. I say *might be,* because you have to determine whether gain or fidelity and stability—or what proportion of each—is desirable.

The first system is education: for simplicity, public schooling through the first 12 grades.

Public school systems traditionally have derived their revenue from local sources, principally through the property tax. As the more affluent members of society tended to gather in suburbs, their more substantive tax bases afforded their communities better school systems. These communities attracted the more intelligent and productive people to them and further increased their affluence and the quality of their schools.

In other communities, for example the inner cities, the poorer education made youngsters less productive after graduation, capable of supporting a less expensive school system than suburban graduates. The more capable and ambitious residents tended to migrate to areas of better schools; the school system was weakened further. The problems from supporting schools this way are now well known and identified, but society took 75 years from the time Edison fired up his two generators to identify the same problem.

Solutions can be postulated which are a mixture of Edison's approach and of the wise man's. Edison used brute force: he geared his generators together so they had to go at the same speed. This is what we are doing today: bus the children from school to school so that all schools go at the same speed. It works, but it costs agony, force, and a lot of buses.

Inverse feedback would probably yield a better solution. We are accomplishing it to some extent with federal and state support to local schools. Federal money in particular, due to the progressive taxation principle, is inverse-feedback money. The federal government takes from the rich and gives to the poor; thus, the more it funds schools, the more inverse feedback is in the system.

My purpose is not to describe how our school systems should be funded. I want to clarify what should be expected from the funding source chosen so we can make better decisions with less acrimony.

If we want an unstable educational system that provides education from brilliant to nonexistent, then we should rely on local funding only. That will give the highest gain—the greatest educational achievement, although it will accrue only to a small minority. And if a community develops a good educational system but then meets with hard times, the positive feedback will weaken the system by amplifying and reinforcing the prejudices of the local community. If we want equal educational opportunity for all, at the expense of a lower top level of educational achievement, then we should fund with federal money to give more support for backward schools.

The school systems are models of our social structures. Haven't we found through our country's almost 200 years of history that an entirely free *laissez-faire* society yields tremendous economic gains—but that the cost is serious distortion and in-

Nature uses inverse feedback: we do not see systems in nature that jack themselves up by their own bootstraps

stability in the fabric of the society: the rich get richer and the poor get poorer? Haven't the Russians found that the Marxian doctrine's pure inverse feedback—from each according to his abilities, to each according to his needs—leads to no gain and pure equality (and too solid stability)? The real question is of the balance of stability. But we disguise that question in terms like "Communist-inspired," "un-American," and "capitalist imperialism."

To Balance Train and Plane

A second example of feedback in society is our transportation system: for simplicity, rail, airline, and highway systems.

Currently, the highway system receives government funds for construction and maintenance. These funds come principally from taxes on fuel, on tires and other parts. The government supplies the airlines with terminal facilities and navigational aids, funded from taxes on fuel for general aviation and on airline tickets. Except for Amtrak, the railroads receive little financial support and in fact pay substantial property taxes on their rights-of-way. The first two have the form of a user tax—positive feedback.

The wise man at the oasis could have predicted the results. As more people drive, the tax revenues increase and pay for more and better roads, so more people desert trains to drive and thus further increase the automotive tax revenues. The logical end is a country paved from coast to coast. Similarly, our airline industry offers ever-better equipment, more sophisticated navigation aids, larger terminals, more frequent flights: you can fly from New York to Chicago almost every quarter hour. Yet rail traffic drops and rights-of-way are abandoned.

Air and automotive travel have inherent advantages over rail travel. The management and labor practices in the respective industries affect their performances. But when it takes longer to fly from New York to Philadelphia now than it did 30 years ago, and when our cities have monumental traffic jams, it is obvious we have not reached the optimum balance among these three modes.

Suppose that gasoline tax revenues were used to develop better railroad terminals, reservations, signalling and communications equipment; railroad taxes to finance aircraft navigational aids and landing facilities; airline tax revenues to build new roads and super-highways? What would happen?

Under present conditions, the construction of new aircraft navigational facilities and terminals would almost cease while revenues would still flow in to complete the highway building program. Meanwhile, the railroads would have substantial funds to improve until they could compete. Their success would again provide revenues to improve the airlines. A stable transportation system would ensue; and the relative emphasis on different modes would be determined by the relative tax rates. Raising the gasoline tax would improve rail service which would, in turn, improve air service, and a new stable operating condition would exist with decreased emphasis on the automobile.

And It's Only Natural

Revolutionary! If we are talking about man-made social systems, it is; but if we look at physical and biological systems, it is not. We have called it the balance of nature.

As vegetation grows, it takes nutrients from the land, draws carbon dioxide from the air, and releases oxygen into it. As herbivores eat the plants, they return nutrients to the soil and oxidize the carbon to carbon dioxide. Meat eaters, in turn, live off the plant eaters and return more nutrients to the soil. As each element thrives, it competes more strongly with its own kind and supports the others. Nature uses the inverse feedback principle to maintain its balances. We do not see systems in nature that jack themselves up by their own bootstraps.

To Prevent Boiler Scale

A second engineering principle that might well be applied to social systems is called "blow down." For example: in a steam engine, steam is, of course, supplied by a boiler. In most uses (except the steam locomotive), the exhaust steam is condensed back to water and pumped back into the boiler to be used again. As the engine runs, it loses a small quantity of steam through leaks in valves, packing glands, and mechanical seals. It constantly needs a small quantity of make-up water.

The make-up water causes a problem. The water lost as steam is distilled, but the make-up water contains dissolved solids and impurities. The constant introduction of impurities, even though the make-up water is of small volume and relatively pure, means the impurities in the boiler concentrate, so that eventually boiler scale forms and reduces efficiency.

One solution is to distill the water used for boiler feed, but the most common approach is "blow down." A small valve is connected to the water reservoir of the boiler and a small quantity of water is bled off.

The make-up water must, of course, be increased to compensate for the "blow-down" water. If the "blow-down" flow rate is adjusted to about 20 per cent of the total make-up rate, then the concentration of impurities in the boiler system will not exceed five times the impurities in the feed water. This is normally an acceptable concentration. Since "blow down" is only one quarter of the losses through leaks, it is a small water loss.

The cost of maintaining a "blow down" is primarily the fuel cost in heating water to be drawn off. The water itself costs but little. The amount of "blow down," and hence its cost, is a function of the impurities in the feed water.

Irrigation provides another application of "blow down." If fields are flooded and the water allowed to stand until it evaporates or is absorbed by plants, the dissolved salts will remain in the soil and build up until they poison the soil. This has been a problem in reclaiming the biblical lands and is becoming one in California. The solution is "blow down"—to allow some of the irrigation water to run off and take with it a higher concentration of salts than the irrigating water brings in. The soil remains fertile.

And To Prevent Stagnation

The principle can be applied in social systems. For example, an organization loses some personnel by natural attrition—deaths and retirements; others resign to take better jobs. Natural attrition will take those of high and low capability evenly, but those who resign to take better jobs are usually the most talented. The organization does its best to bring in good personnel, but it will make mistakes.

If the organization is of constant size it tends to concentrate within it the less competent.

If the organization is expanding, the influx of new talent dilutes this tendency, particularly since the organization will probably recruit the distillate of other organizations. On average, the growing organization should thus have an above-average staff. If the organization is shrinking, it will have no dilution, and the average quality of personnel suffers even more.

Here we see the distortions of positive feedback. A growing organization tends to have above-average people; this helps it grow even more. A stagnant or contracting organization tends to have the less competent; this makes it less capable of growing.

Were "blow down" applied, some fraction of employees would be let go every year and their number replaced from outside the organization. This practice is seldom implemented. Usually firms wait for economic sloughs to reduce staff. This is like shutting down a boiler to clean it out. A business recession is sometimes viewed as a blessing because it lets a firm "get rid of the deadwood" and "cut out the fat."

What would it cost to begin "blowing down"? The individuals let go would suffer a personal hardship, and the company some discomfort as well. This cost would be hard to assess, but it would be balanced by two other factors. If the people fired are "deadwood," they would be fired anyway in the next recession. Better it be done when getting another job is easier. Second, the man who has been fired from one position—perhaps he was a square peg in a round hole—may well find a rewarding new job, albeit after a traumatic experience and search.

The other obvious cost is the loss of trained personnel. But this seems a small price for the benefits obtained. The number of people let go need not be large to make the policy effective.

The organization has two advantages over the steam boiler. It can sort out those individuals to be "blown down." The steam boiler loses average water with average impurities.

And if it is known that the bottom fraction of the personnel roster is trimmed every year, there is a strong incentive to keep off the bottom.

"Why Not Swap Horses?"

I raise these ideas not to champion the solutions proposed but to make readers aware of the techniques involved. Other problems show the results of positive feedback or lack of "blow down."

Doesn't our health care system show signs of positive feedback? At its best, health care in the United States is unsurpassed. Yet health care for the poor can be improved; and if life expectancy and infant mortality rates are good indices of overall health care, the United States compares poorly with the other developed countries.

How often are government programs terminated? Don't we tend to retain useless positions and programs? Perhaps a "blow-down" system that forced the discontinuance of some programs or positions each year would also force some decisions about what was worth keeping.

Building a "blow-down" or inverse-feedback system in any of these contexts would be hard, but I believe the gain would be worth the effort. At the least we can apply them mentally as we analyse a troublesome situation. When we face a stagnant situation, we can think in terms of "blow down." When we face a situation where the gain is great but the fidelity or stability is low, we can stop thinking of bigger gears and heavier shafts. Instead, we can remember the wise man at the oasis and say, "Why not swap horses?"

When it comes to community concern... we try to pull our weight

"We" means Whirlpool — as people and as a company. And we care about the communities we work in.

We share an equal concern with our neighbors about the quality of education, neighborhoods, and the overall environment of our community. That's why you'll find our employees pitching in on all kinds of people-for-people projects.

Like raising funds for a Day Care Center to provide a wholesome educational environment for children of working mothers. Or sticking with it on a community action group that's trying to arbitrate differences at the local high school. Or helping organize neighborhood ecology projects to round up old bottles and cans.

As a company, we're pulling our weight in other ways, too. By investing the money necessary to make sure our plants meet or surpass federal and local standards for cleaner air and water. And by putting financial support and know-how to work on problems that need solving — such as sponsoring a neighborhood center that's providing information and guidance to help people help themselves in a low income area that can still be saved.

Whatever the activity, Whirlpool people and resources are there. We get involved. And we like it. Because concern for the communities we do business in, is a long term investment with Whirlpool. We know that if the community doesn't grow, we won't either.

Whirlpool CORPORATION
BENTON HARBOR, MICH.

Being good neighbors is something we work at.

Trend of Affairs

Trends This Month

COMPUTING

How many believe in an omniscient machine? . . . Reactions against "efficient" salesmanship.

ENERGY

In the fusion stakes, a dark horse joins the favorites . . . A subway's heat-disposal problem . . . Waste not, want not? . . . What we'll pay depends on how we grow . . . Fossil fuels: using the bottom of the barrel.

WASTE DISPOSAL

What are the cancer agents in city air? . . . Cleaning up the spaceways . . . Unexpected industrial effluents . . . Plastics: a costly new solution.

LIFE SCIENCES

Do fish breathe out the poisons that birds accumulate? . . . and navigate by smell? . . . The toolkit of a very constructive virus.

TRANSPORTATION

Lost freight cars, and other research tasks . . . The theft-proof bicycle, at last? . . . The hard school of urban vehicle design.

PHYSICAL SCIENCE

A wind-gauge for all seasons . . . Difficulties of a chemical engineer.

OCEANS

Of a dozen sea-related technologies, four show promise . . . Spinoff from undersea engineering . . . Something between a hydrofoil and a submarine.

BIOENGINEERING

Electrical feedback in a growing bone . . . But not between hospitals and instrument makers . . . How to keep the patient away from the power supply.

COMPUTING

People vs. E. D. P.?

Should computers be used more widely to keep track of criminals? Are computer mistakes really mistakes made by the people who use computers? Could a computer disobey the instructions of its operators? Or encroach on personal privacy?

Questions like these were asked of 1,001 people chosen at random in a survey of public attitudes commissioned by *Time* magazine and the American Federation of Information Processing Societies, Inc. The result confirms the idea that peoples' attitudes about computers are shaped from informed opinion and just a little uninformed science fiction. For example:

☐ 65 per cent said computers were helping to raise the standard of living, 60 per cent that business would be in serious trouble without computers; but only 36 per cent said computers created more employment than they eliminate.

☐ 81 per cent agreed that "computer mistakes" were really mistakes made by people who use computers; and a surprising 75 per cent said they had no problem getting a computer-generated bill corrected.

☐ 55 per cent felt people were becoming too dependent on computers, and about the same percentage believed computers were de-humanizing people and "turning them into numbers"; in contrast, 71 per cent answered that the use of computers has "made life better."

☐ 38 per cent felt computers represented a "real threat" to personal privacy (53 per cent believed computerized information files might be used to destroy individual freedom); nevertheless, 78 per cent wanted more use of computers to keep track of criminals.

In the realm of science fiction:

☐ 12 per cent thought of computers as being able to think for themselves, while 30 per cent thought computers could produce more accurate information than they were given.

☐ 17 per cent believed computers of the future "will be able to read your thoughts," while 23 per cent said computers might "disobey the instructions of the people who run them."

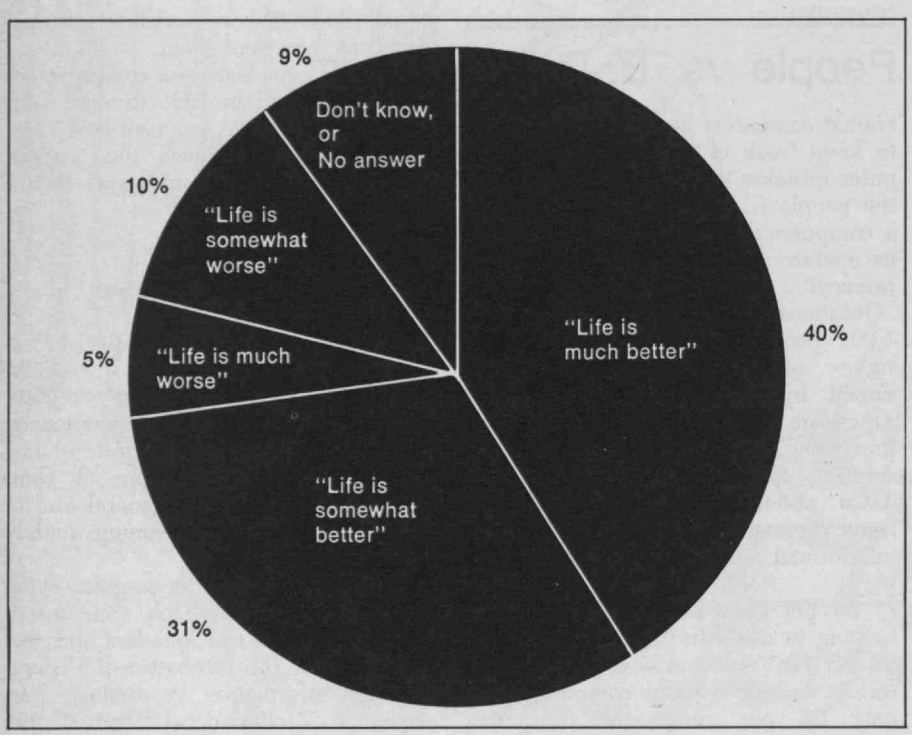
—*Michael Chiusano*

Computer Users Grind Their Axe

Participants to various recent computer events in Europe have experienced something that has given quite a new sensation: massive criticism of computer manufacturers in general and of I.B.M. in particular, coming mainly from U.S. speakers.

It seemed like a rather singular event when Isaac L. Auerbach (an American, and one of the founders and first Presidents of the International Federation for Information Processing) presented a "Technological Forecast" paper at the I.F.I.P. Congress 1971 saying that computer people had lost their perspective. "After 25 years of dramatic progress in hardware development, we continue for the most part to apply computers to scientific and commercial workloads in a piecemeal fashion, tending to view them merely as efficient replacements for the calculators and accounting machines of the past. Our accomplishments in the effective applications of computers have simply not kept pace with our progress in hardware and software technology."

But even stronger criticism was expressed at "System '71," an international symposium held at Munich, West Germany, in December 1971. Henry F. Sherwood, Vice President of Diebold-Europe, gave his introductory lecture the title "The Users Have Come of Age." He dealt with the deep disappointment amongst users of electronic data processing in the commercial field because of the fact that, in spite of increasing costs, results are far behind expectations. Whether expectations



"Overall, what has been the effect of the use of computers on the quality of life?" In 35-minute telephone interviews with 1,001 U.S. adults, Lieberman Research, Inc., working for *Time* magazine and the American Federation of Information Processing Societies, Inc., found a generally positive public judgment. But some 30 per cent of those interviewed blamed computers for some kind of problem—ranging from errors on bills to "I lost my job to a computer." (See previous page.)

have been pushed too high by too many promises on the manufacturer's side, by too great "efficiency" on the part of their salesmen, or by too little understanding of the problems on the user's side does not make much difference: the result is a deep distrust of the manufacturers, focussing on the leading manufacturer, I.B.M.

This distrust was further strengthened by Herbert R. J. Grosch, of the National Bureau of Standards, Washington, who in his lecture on "Standardization and Compatibility" accused manufacturers of defeating standardization for the sake of their own business interests. He very much doubts whether "mixed hardware," "unbundling" and the rest of the anti-monopolistic measures will have any effect in the reality of the market situation. In its dispute over the application of U.S. anti-trust laws, I.B.M. is fighting with a sharp-edged axe, the Department of Justice with a wooden sword: two government lawyers dealing with I.B.M. as against an I.B.M. expenditure for lawyers of $200 million a year. Unless the users themselves will also grind an axe, said Grosch, there is no hope of finding any counterweight to I.B.M. The audience, mostly users, seemed to take up this suggestion rather enthusiastically.

Dr. Grosch further developed his ideas at another congress, held at Salzburg, Austria, in April 1972. It was the 3rd International Congress on "Data Processing in Europe", and Dr. Grosch posed the question: "Will there be a European computer manufacturer?" The answer he gave was a very blunt "No." He predicted, on the contrary, that by 1980 I.B.M. will rule 90 per cent of the computer market, while most of the other firms will have disappeared. Mr. Grosch's audience was left puzzled as to whether this spelled "unconditional surrender" to I.B.M. or whether users should carry on their fight for independence.

An argument much on the same line came up against Austria's government. The draft of a governmental plan for development of computer use in public services, supposed to pass Parliament by October this year, envisages "unification of computer installations." This was interpreted and criticised by the Press as accepting I.B.M. monopoly for the future. In fact this is not the intention of Austria's government, but it might very likely be the result in the absence of positive countermeasures.

Discussion now focusses on two ways to avoid monopolization, probably both necessary. One is for the user to ensure open competition, avoiding what Mr. Sherwood at Munich has illustrated in a story: A U.S. plane once got into difficulties on a flight to Mexico. The captain called on his three passengers —two white, one black—and explained to them that one had to be sacrificed. To prove his correctness and to avoid any prejudice, he would ask every one of them a question, and the one who could not answer it would lose. His first question he put to one of the white passengers: When did we drop the bomb on Hiroshima? The answer came immediately: August 6th, 1945! Then he asked the other white passenger: How many were killed by that bomb? He too could answer correctly, after some hesitation: Out of 340,000 inhabitants, 86,117 were killed. Next he asked the black: What were their names? Moral: competition is often more apparent than real.

The other way of achieving independence for the user is now being discussed by experts both in government

and in private firms: the idea is to build up a nationalized software firm. With some 20 per cent of Austria's industry nationalized, and a further 20 percent of Austria's economy such as banking, transport, energy supply and the like under public control, a nationalized software firm would have a solid basis both of experts and of customers to build up a flourishing business and to give Austria's computer users a firm ground on which to stand against manufacturers. It is only an idea, so far, but it is considered worth thinking about and it might be taken up by other countries as well.—*Fred Margulies*

ENERGY

Laser Fusion Grows Respectable

Discussion of the prospects for controlled nuclear fusion—with its promise of endless power from the hydrogen of the sea—has generally centered around the topic of containment: of containing, that is, a gas at a high enough temperature and pressure, and containing it for a long enough time, for a useful amount of nuclear fusion to take place (*see for example, "The Quest for Fusion Power" by Lawrence M. Lidsky,* Technology Review, *January 1972, pp. 10-21*). Containment is supposed to be achieved by the use of magnetic fields, and the main argument has been between proponents of different designs of magnetic fields.

The Atomic Energy Commission is now publicly looking with equal favor upon another scheme, termed "inertial containment," hitherto generally regarded as a much less likely contender. In an inertial containment device, fusion conditions would be attained by striking a solid pellet (or drop of liquid) containing the fusionable material with a very intense laser pulse. The material becomes an expanding cloud of vapor, but for a certain brief time, due to its inertia, it is still compact enough for fusion to occur.

Laser-induced fusion is indeed well established, but the amounts of energy released are small compared with the input laser energy in work reported to date. At least since 1963 (when the first small neutron yield was reported at the Lebedev Institute in Moscow) such work has been undertaken by a number of organizations, including the University of Rochester, the Los Alamos Laboratory of the University of California, the A.E.C.'s Oak Ridge Laboratory, and K.M.S. Industries, Inc.

The last-named caused something of a stir two years ago when its attempt to file nine patent applications in this field was abruptly halted by the A.E.C.; the chairman of the company, Keeve M. Siegel, claimed at that time that a fusion reactor was only ten years off. For a time the Commission stopped K.M.S. from working in the field at all, but early last year the company was "permitted to conduct, at its own expense, a research and development program in which it would attempt to achieve by the laser method thermonuclear reactions that might be applied in a potential fusion power reactor." However, "if, in the future, the A.E.C. determined that the work was leading to the fabrication of a nuclear explosive device. . . . the K.M.S. program would be ended or redirected toward peaceful applications." The A.E.C. let it be known that "its approval of the K.M.S. request should not be interpreted as indicating a belief that K.M.S. can achieve its goal within a commercially reasonable time."

The reason for the A.E.C.'s misgivings about letting K.M.S. do what it wished with its own funds is presumably that laser-induced fusion could provide the basis not only for a power station but also (indeed, more easily) for a hydrogen bomb which needed no fission detonator. The Commission has the power to control private research having military potential—and specifically, laser-induced fusion work—under an amendment, introduced four years ago, of the Atomic Energy Act.

Aside from the work which the A.E.C. has been conducting in the public eye, the Commission's Division of Military Applications has a laser-fusion weapons program, a necessity which in this year of energy-anxiety is being made a virtue. In February Los Alamos published Volume I of an A.E.C. report entitled *Central Station Power Generation by Laser-Driven Fusion;* Volume II, which "outlines Los Alamos Scientific Laboratory's laser program, discusses the problems of achieving laser-driven fusion, considers subsequent neutronic interactions, and gives some economic implications," is classified.

The Los Alamos report is devoted to a type of reactor called the "wetted wall concept." In essence, the device is a double-walled enclosure, with liquid lithium flowing between the walls, and with the inner wall perforated so that a layer of lithium leaks on to its inner surface (it drains away through an exit at the bottom, for recycling). This inner layer of liquid protects the inner wall from erosion by the exploding pellet material. Each pellet, on detonation, releases 200 megajoules of energy (equivalent to about 100 pounds of TNT). Pellets are injected and detonated at a rate of one per second. The lithium acts both as primary coolant and as a source of tritium (into which it is partially converted by the neutrons emitted in the fusion reaction); the tritium thus "bred" is needed as a fuel. The wall structure, with its liquid lithium content, constitutes a shock-absorber against the considerable oscillatory forces. The Los Alamos report devotes much attention to the blast-containment aspect of the system, shows some remarkably realistic-looking graphs of pressure and wall-movement, and notes that "the failure mode is fatigue."

How close the Los Alamos team is to making a real internal-combustion fusion power plant will be more evident to those who are cleared for Vol. II. The first volume is not only, as fusion proposals go, unusually pragmatic, but also somewhat optimistic in its language.

The May issue of *Environment* contains an account of various laser-fusion systems by two physicists at the Lawrence Livermore Laboratory who claim that "a laser-fusion microexplosion system which would produce net electrical energy could be operational sometime around 1975." Their favored system uses smaller explosions (about 10 megajoules); they reason that, in that case, to be economic the cost of a fuel pellet would have to be below one cent. This is one of the questions which the A.E.C. confines to the classified volume.—*F.W.*

Heat of Transport

The climate of New York's subways is changing.

No social commentary, this. Since 1904, when 24-hour subway service began, "there has been a continuous and perceptible buildup of heat in the ground surrounding our tunnels," William J. Ronan, Chairman of New York's Metropolitan Transportation Authority, told an M.I.T. Alumni Center of New York seminar this spring.

A General Electric study confirms the build-up of heat and suggests three sources:

☐ The trains themselves, whose motors and heating systems add increments of heat to the tunnels; 600 new, air conditioned cars especially contribute a disproportionate share of heat.

☐ Manhattan's increasing energy consumption, which affects the temperature (and cleanliness) of the air that can be brought into the tunnels from the streets.

☐ The increasing number of subway riders (80 per cent of the commuters on and to Manhattan Island use mass transit, and a large share of these use the subways).

Is the problem serious? Not really, in terms of the foreseeable future—except for the "revolution of rising expectations" which is now affecting mass

transportation as well as many other services. Subway heat, noise, and vibration which nobody used to complain about are now considered excessive. There is even a demand for isolating and air conditioning subway platforms.

Achieving higher standards of comfort, said Dr. Ronan, will bring the subway system squarely into confrontation with a still more basic problem. Already the Metropolitan Transit Authority uses 11 per cent of all the power generated by Consolidated Edison. With Con. Edison unable to win environmentalists' support for more generating capacity, can the M.T.A. system afford the luxury of air conditioned stations, even on new lines where it would not encounter the "formidable" problems of reconstruction?—*J.M.*

"We Are All Part of the Problem. . ."

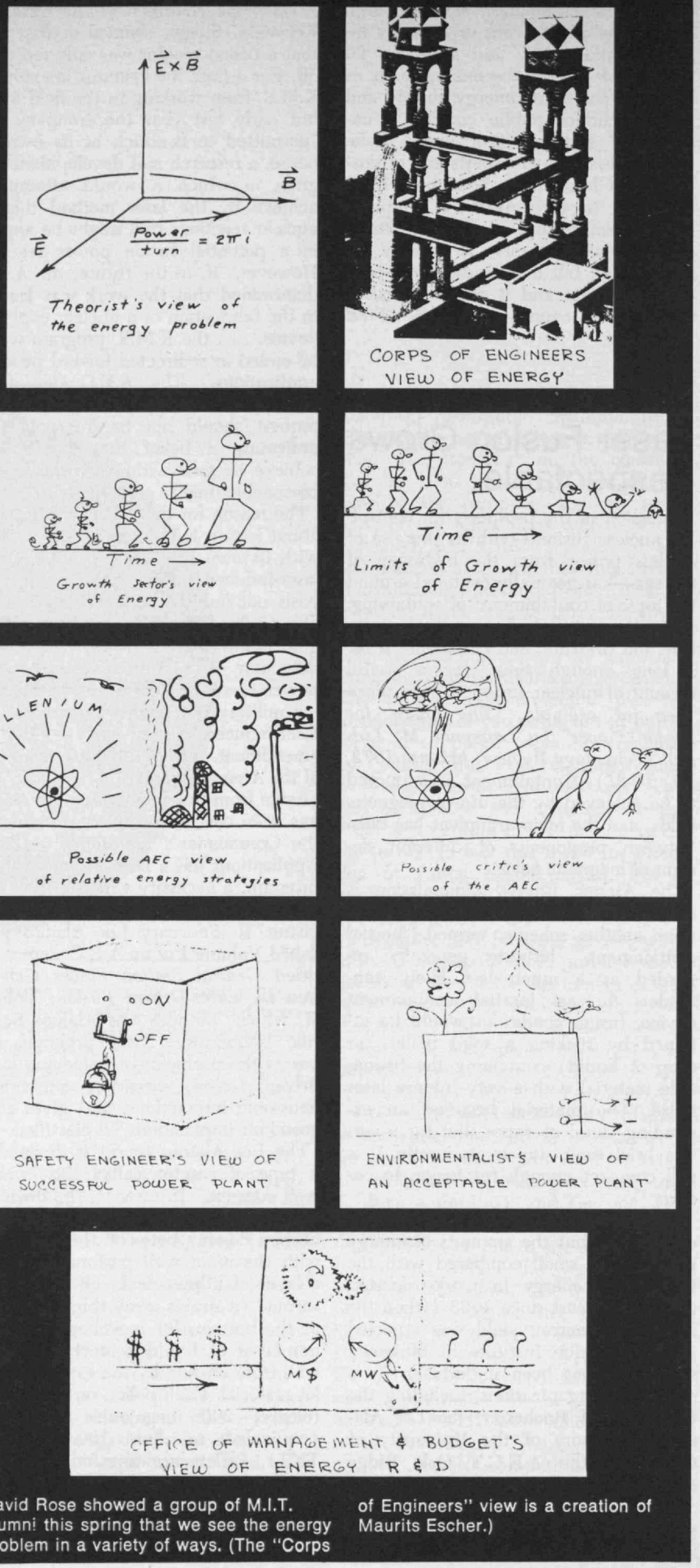
The nation's energy problem is more than the search for more oil and coal, the hope of the breeder and fusion reactor, and the pursuit of more efficient energy converters. It is, in fact, an issue interwoven into our economic and cultural life, and no resolution of any single question is likely to relieve us of the need to understand and perhaps change the role of energy in modern life.

The House Subcommittee on Science, Research, and Development this spring embarked upon a long-range inquiry into energy resources and consumption. James R. Killian, Jr., Chairman of the Corporation, and one of five members of the M.I.T. community called upon to address the Subcommittee on the first day of the inquiry, observed that "we are all part of the problem, and we must all become a part of the solution."

How to approach such a massive issue? Keep pressing on all the conventional technologies for fossil and nuclear fuels, said David J. Rose, Professor of Nuclear Engineering. And don't expect a sudden miracle from solar energy or some less conventional source. Only fossil and nuclear sources are consistent with our present dependence on highly concentrated energy sources.

The best estimates are that collector devices may yield low-temperature solar energy at an overall efficiency of 10 to 15 per cent, said Dr. Rose. He dismissed more exotic "solar cell" proposals, including plans to place solar collector assemblies in space, as being now "too expensive by a factor of nearly 100."

What about winds and tides? "All the power extractable from all the winds that blow across the U.S. below an altitude of 100 meters comes to only a



David Rose showed a group of M.I.T. alumni this spring that we see the energy problem in a variety of ways. (The "Corps of Engineers" view is a creation of Maurits Escher.)

few times the present power use." And ocean currents, Dr. Rose said, represent such a very dilute energy source that tapping it seems out of the realm of possibility.

But there is an important, almost unexplored frontier—the demand side of the supply/demand equation. Pay attention to "leaks in our energy system," said Professor Rose—the escape of hydrocarbons, which are really unburned fuel; the use of excess active fertilizers; the waste of reactive chemicals; our dependence on throw-away containers; designs that create unnecessary demand for heat, light, and air conditioning.

"If energy were some great herd of animals, whose services and benefits we could not do without, but whose breath, appetite, and droppings did what we see our energy strategies presently doing," said Professor Rose, "then we wouldn't have so much trouble visualizing or accepting the concept."

How to proceed toward a more rational energy policy which may avert a crisis? The first step, said Dr. Killian, should be a task force study of "technological implications and imperatives of selected national energy policy alternatives." What he meant, he said, in words of the National Science Board, is a "menu of alternative solutions."

The next need, said Dr. Killian, is a program of "large-scale, mission-oriented energy research by mission-oriented agencies." Up to $1 billion a year could ultimately be devoted to such a program, he said, and he supports the plan for a Department of Natural Resources as its focal point. One trouble today, he said, is that "much of our research is in small pieces; we have not adjusted our research and development program to the critical size necessary to cope with some of our most urgent problems of both supply and use." —*J.M.*

More About That Exponential Curve

"Pitch," said Mr. Squires. "Pitch. That's what we should put our money into—getting fuels from pitch. The gummy stuff at the bottom of a barrel of oil."

The exponential curve of energy use predicted for the rest of this century tells us we will be scrambling for any kinds of fuel we can get; and these will surely include fuels that are harder to make clean and useable than natural oil and natural gas—such as oil from shale and coal, synthetic natural gas from coal, oil from tar sands and pitch. (Dr. Squires is Professor of Chemical Engineering at City University of New York; he wrote "Capturing Sulfur During Combustion" for the December, 1971, issue of *Technology Review*.)

"Actually, the question is not one of running out of fossil fuels," David White, Ford Professor of Engineering at M.I.T., told an alumni seminar in Washington this spring. "We still have vast reserves. The question is what price we will pay."

Already it is clear that we will pay—soon—higher prices for fossil fuels and the energy they produce. The higher cost will pay for processing shale, tar sands, coal, and pitch. Oil, for example, will cost perhaps $6.00 per barrel instead of $3.50 well before the year 2000, said Dayton Clewell, Senior Vice President of Mobil Oil Co., and other inflationary forces are also working on the price of energy. The cost of installing a coal-burning plant to make electricity could triple in ten years, Roger Carlsmith told the M.I.T. alumni—partly because of the devices that will be required to handle waste heat and emissions. (Mr. Carlsmith is associate director of the National Science Foundation's Environmental Program at Oak Ridge.)

But what would happen if heat and electricity and fuel all cost twice as much? Perhaps not much, but no one knows yet. Professor White is beginning to build a model that he hopes will give useful answers. Mr. Carlsmith told the seminar of two curves that made rough predictions.

If in the next 30 years our population grows by only one-half of one per cent per year and our per capita income rises by 2½ per cent a year, and if by the year 2000 electricity and fuels cost twice as much as they do now, we ought by then to use less electricity than we will in 1980. Other predictions, based on larger population and G.N.P. growth, instead show larger energy consumption—not a continuation of the recent trend of exponentially increasing energy consumption, but no vast reduction from it.

Because our energy has been cheap, said Steven Rattien (who works for the Council on Environmental Quality), we have developed bad national habits in using it: in our use of tools and materials we have chosen the energy-intensive rather than the labor- or capital-intensive. Our "voracious appetite for energy" will be hard to rein in. But, Mr. Carlsmith pointed out, since last June the F.H.A. requires more insulation than before in new homes under its domain. And several speakers pointed out that the overall cost of energy rose last year for the first time in our history.

High time: As David J. Rose, Professor of Nuclear Engineering at M.I.T., said, we presently devote 1/10 of our gross national product to the purchase of energy and to the consequences of cheap energy.—*J.K.*

"Pitch," Said Mr. Squires

Only one per cent of our power now comes from nuclear plants; by A.D. 2000 only 27 per cent will be nuclear. We will use three times as much energy as now, and for most of it we will still depend on fossil fuels. Dayton Clewell of Mobil Oil Co. (see above) gave M.I.T. alumni at a seminar in Washington a breakdown: by 2000 we will use 36 million bbl. of oil, enough natural gas to equal 21 million bbl. of oil, coal to equal 16 million bbl. of oil, hydrodynamic power to equal 2.3 million bbl., and nuclear fuels to equal 30 million bbl. The equivalent of 30.9 million bbl. of oil will be lost in the conversion of fuel to energy, he said—an amount slightly larger than that produced from nuclear fuels and that used for transportation.

Three separate meetings—the alumni seminar on energy at which Mr. Clewell spoke, a symposium at the American Geophysical Union (A.G.U.) meeting in Washington four days later, and one at the American Chemical Society (A.C.S.) meeting in Boston the week before, dealt with what reserves of fossil fuels we have, how to get at and use them, and what problems are associated with them.

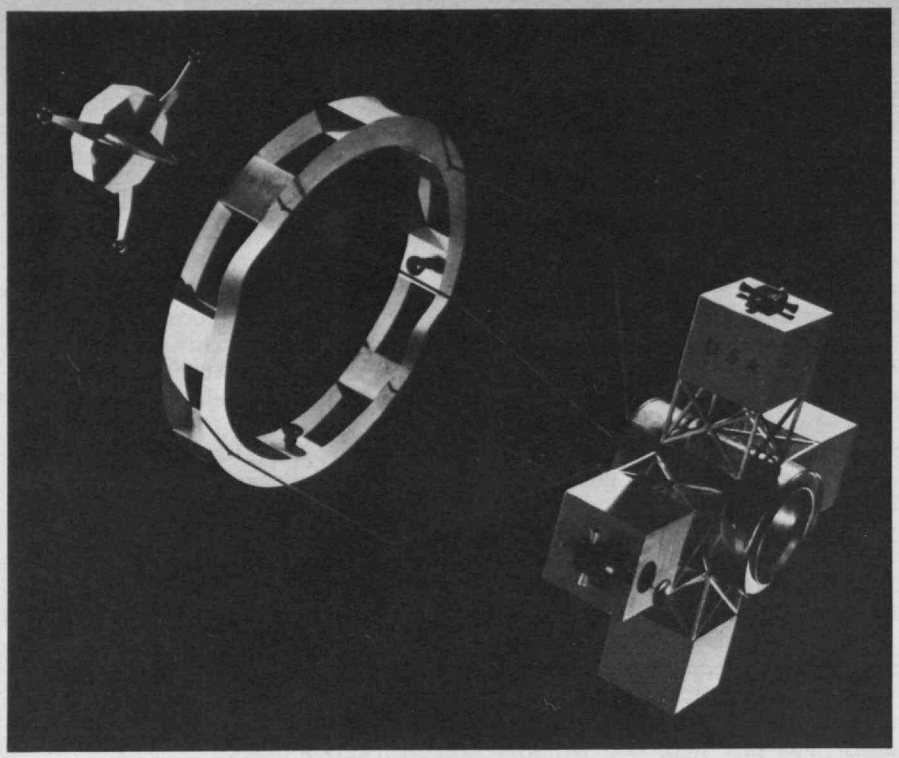
We ought to count on using no more natural gas than we use now—already we have shortages. Coal we have in plenty, but little of it that is both low in sulfur and near where it will be needed. As we develop new methods of prospecting and mining we will find more oil accessible. Oil from shale, Mr. Clewell said, looks especially promising. The reserves in Colorado are large, and when the oil can be extracted from the shale under ground ("in situ") the process will be profitable and clean.

David J. Rose, Professor of Nuclear Engineering at M.I.T., did not agree—he fears the environmental impact of mining shale oil will be frightening. Not so, Mr. Clewell declared: the shale would be some 2000 to 4000 ft. underground and the oil content is perhaps 8 to 10 per cent—not enough substance would be removed to weaken the rock structure.

The A.C.S. meeting heard of a process that would extract oil from shale above the ground, from two researchers from the U.S. Bureau of Mines. Sidney Kattell and Paul Wellman propose that shale be dug out of three mines in the Roan Creek area of Colorado, crushed and retorted there, and the crude product shipped for preliminary refining to a plant to be built at DeBeque. The mines would together yield 174,820 tons per stream day of raw oil shale containing 30 gal. per ton of oil; 12

retorting units would each turn out 9,693 bbl. of crule oil, 86,242,000 cu. ft. of low-B.t.u. gas, and 11,160 tons of crumbled shale. The shale would be dumped in nearby canyons, the authors said, and in used mine shafts as they become available. The refinery at De-Beque would process the crude oil to make hydrogen, sulfur, ammonia, coke, and semi-refined oil that could sell for $3.74 per bbl. as a break-even price.

Coal, Kurt Yeager from the Environmental Protection Agency told the A.G.U., is the most pollution-intensive of all our fuels. By 1975 we will need 600 million tons more low-sulfur coal than we will mine. Burning high-sulfur coal and trying to clean the smoke looks frustrating and perhaps fruitless: Arthur Squires pointed out that one unit at the new generator at Lawrence, Kansas, the showpiece of sulfur dioxide treatment facilities (*see* Technology Review *for June, 1970, p. 72*), is down after only 750 hours of operation because its scrubber is clogged. "You can't call that a developed process," he said.—*J.K.*



This proposed device for retrieving unmanned orbiting objects provides a means of overcoming a major difficulty, namely that such objects will in general be spinning.

WASTE DISPOSAL

New Airborne Carcinogens

Though statistical data indicate that breathing urban air contributes to lung cancer, the mechanism remains elusive.

It is well known that the incidence of lung cancer "seems to match up" with the concentration of benzpyrene in the air, Dr. Samuel S. Epstein of the Case Western Reserve University's School of Medicine told the American Chemical Society in April. But when extracts of urban air pollution are smeared on the skins of laboratory rats, it is "impossible to demonstrate" a relation between the benzpyrene content of the sample and its tumor-causing potential.

Nevertheless, there is significant variation in incidence and type of tumors caused, in the same type of test, by air pollution extracts taken from different cities. (A questioner asked if this correlates in any way with incidence of cancer in those cities. Dr. Epstein said "we haven't looked into it.")

There are many known carcinogenic compounds commonly found in urban air, Dr. Epstein continued, many of which have been virtually ignored in research. So it is clear that benzpyrene is not the only chemical carcinogen in the air.

But what are the others? To try to find out, Dr. Epstein collected 10 kg. of particulate air pollution in New York City (using air conditioner filters). He separated the pollutants into several fractions and injected mice subcutaneously with suspensions of the various substances. This is "a particularly sensitive" test for carcinogenicity, he said.

The variation in effect was wide. One category, a basic group of organic fractions, proved the most carcinogenic; this portion made up about 0.5 per cent of the total pollutants collected in the experiment. Dr. Epstein suspects that the particular culprits in this group may be a group of compounds called dialkylated benz(c)acridines. These are compounds which happen to be more common in the air of cities burning solid fuel rather than liquid fuel. —*R. A.*

Astrojunk

It is not, apparently, too soon to consider the problem of orbital solid waste. An aerospace engineer at Pennsylvania State University has just received an extension of the N.A.S.A. grant under which he is designing a device for retrieving large pieces of junk from space.

"There are about 2,600 objects now in earth orbit," says Dr. Marshal H. Kaplan, "and most of them must be considered as space garbage. There may soon be enough of it to jeopardize future space missions: cast-off rocket stages, payloads, and satellites that no longer work."

The typical space-hulk will be spinning, making it hard to secure. So Dr. Kaplan has devised a "retrieval unit" (a model of which is shown here) consisting of a 14-ft.-diameter metal ring, fitted with spin motors and inward-facing arms. The ring is dispatched and controlled by a manned craft, which hovers within visual range of the lump of junk while the ring is spun up to a matching rate of rotation and pinions the object. Ring and hulk are de-spun, and the latter can then be taken to the control craft, either for repair and re-use or for redirection into a lower trajectory where it will burn up in the atmosphere.

Dr. Kaplan's current work includes the explorations of methods of rescuing astronauts stranded in faulty or damaged spacecraft.—*F.W.*

Half-known Pollution

The search for pollutants continues, with organic chemicals a particularly elusive component. A recent literature survey showed that of 496 organic chemicals suspected to be in fresh water, only 66 have been identified.

As a start in tracking down the remainder, the Environmental Protection Agency sampled and analyzed effluents from seven petrochemical, synthetic rubber, petrorefinery, and chemical plants. The results, reported by L. H. Keith of the E.P.A.'s Southeast Water Laboratory at the spring meeting of the American Chemical Society in Boston, revealed a curious fact: In several instances "compounds identified in the

effluent . . . could not have been predicted from the list of products and raw materials." For example, from a plant producing butane, octane, ammonia and a number of other organic compounds came effluent with significant concentrations of napthalene, a chemical that was neither a raw material nor a product of the refinery.

Dr. Keith could offer no explanation for the result, which comes from the first mass spectrometer in use by E.P.A. But he promised that such studies will continue and that—by 1975—mass spectrometers will be in use for wastewater analysis in every state. Then the "widespread capability for quickly analyzing specific organics responsible for actual or potential pollution problems" will overcome what he called "a major obstacle of the past—working with unknown compounds." Such positive identification will be "significantly more useful" in characterizing an effluent for law enforcement than gross measurements of biological oxygen demand, suspended solids, or organic carbon, he said.—*Michael Chuisano*

Plastic Wastes: Irradiate?

Among the processes that might be useful in the disposal of solid wastes, irradiation has sometimes been suggested. Two researchers at Wayne State University—one in Civil Engineering, the other in Chemical Engineering and Materials Sciences—have examined the potential of irradiation and concluded that it is useful technically but unfeasible economically.

Masaru Tanaka and Tsuyoshi Mifune considered, in particular, the disposal of plastics, which will make up a growing fraction of municipal wastes in the years ahead and which are especially difficult to process by conventional means. (According to one school of thought, plastics present no problem to a properly designed and controlled incinerator. According to the other school, their high heat content reduces the tonnage capacity of incinerators and can cause damage: their combustion can form gases which are poisonous, corrosive to the furnaces, or both; they can melt and clog incinerators, causing black smoke and offensive odors.) They are too resilient to be compacted for landfill by conventional mechanical means.

But most common plastics become brittle upon irradiation. Experiments confirmed this observation, Professor Tanaka told the A.C.S. this spring, but the required radiation dose is probably too high for the method to be practical for large-scale use.

Using a Van de Graaff generator supplying 1.3-MeV electrons, they found that thin (0.03 to 0.04 in.) plastic sheets had their strength greatly reduced and their ductility completely eliminated after irradiation with about five millicoulombs per square centimeter for polyvinyl chloride and one and one-half millicoulombs per square centimeter for high-density polyethylene.

"Even with quite a large radiation source," Professor Tanaka reported, "it takes extended irradiation to make plastic materials brittle enough for subsequent mechanical consolidation. As the feasibility of the irradiation treatment of plastic wastes for mechanical consolidation depends on economic feasibility of radiation sources and the safety of operation, the method investigated cannot be recommended for commercial use."

He added, however, that the technique might find limited application for special problems like highly toxic hospital wastes. And the economic picture might change if nuclear reactor wastes (like Sr-89, which emits 1.46-MeV electrons) can be used for the radiation source.—*R.A.*

LIFE SCIENCES

Sharks Are Safer Than Eagles

The eagle and condor, it is known, are growing fewer in number partly because the chlorinated hydrocarbons and polychlorinated biphenyls (P.C.B.'s) in their bodies sicken them in subtle ways—the birds concentrate in their tissues certain chemicals eaten by their prey. Do the dolphin and shark, similarly high in their natural food chains, similarly suffer from this "biomagnification"? We have generally assumed that they do.

A silky shark caught off the coast of Georgia had 5.8 p.p.m. of P.C.B.'s in its liver; the liver of a white-tipped shark caught off Cape Verde, Africa, had 1.2 p.p.m. Both levels are much higher than the 0.3 p.p.m. found in the plankton that occupy the bottom of the food chain. Yet a trigger fish—a fourth-order predator like the sharks—also caught off Cape Verde, had only 0.001 p.p.m. of P.C.B.'s in its liver. Why?

George Harvey, a biologist at Woods Hole Oceanographic Institution, will sail aboard the research vessel *Chain* this summer to test his hypothesis that, in marine animals, the levels of P.C.B.'s in tissues depend not on what the animal and its prey have eaten, but on how much P.C.B.'s are in the water in which it lives and on the quality of its tissue fats as solvents.

Because P.C.B.'s are slightly—very slightly—soluble in water, Dr. Harvey thinks, a marine animal can in effect breathe them out; thus P.C.B.'s and D.D.T. and its metabolites may pass across the membrane in the animal's gills and diffuse into the water around it. So, unless the particular animal's tissue fats are better solvents for these chemicals than are those of its prey, any concentration mechanisms would be counteracted.

Dr. Harvey told the *Review* of the work of two Michigan scientists, R. E. Reinert and J. L. Hamelink, who independently fed clean food to fish in water contaminated by P.C.B.'s and contaminated food to fish in clean water. Their test species, algae, daphnia, and guppies, developed levels of P.C.B.'s in their blood that correlated with the levels in the water, not with the food.

This summer—on the 46-day voyage into the northern Atlantic, down to the Azores, and up again to Norway—Dr. Harvey will take samples of several kinds of plankton, and of algae, oysters, and fish at depths of 500 to 1000 m., and of the water they live in.

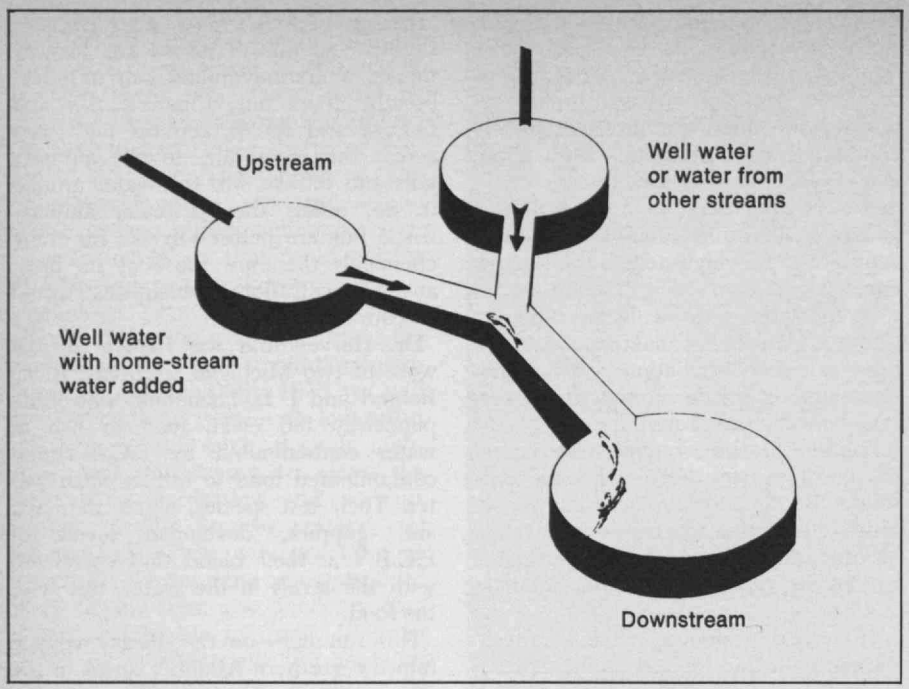
Dr. Harvey spoke also of his concern for the cleanness of the seas: "The evidence suggests that the transfer of material to the ocean is essentially atmospheric; that there is only a trivial contribution in the runoff from land and from rivers." The level of P.C.B.'s found in zooplankton across the North Atlantic is uniform, about 0.3 p.p.m. But the level is very different in the South Atlantic, ranging from 0.6 p.p.m. off the South American coast near Sao Paulo, to 0.1 p.p.m. in mid-ocean, to 0.02 p.p.m. near the African Cape. He thinks westerly winds bring the chemicals from the air over Sao Paulo to the sea. The uniform concentration in the north reflects the uniformly industrialized northern countries.—*J.K.*

Aquatic Songs And Chemical Signals

When the whale reaches the southern sea, the first of his family there, he waits and begins to sing. He sings a haunting and sensitive song, listening to the echoes the sea returns and answering them. He plays with his sounds. He sings for an hour his individual song, a song that carries through the water for many hundreds of miles.

What elicits his song?

Other animals communicate under the sea in just as subtle and precise a manner: how marine communications are elicited and performed is a wide and new scientific concern, described this spring by John Todd, biologist at



Alewives, under the guidance of Woods Hole scientists, face this maze in which they have the choice of swimming upstream into water that contains a sample of that from their home streams and a sample from another source. They nearly always choose the homestream water, and usually refuse to swim upstream at all if none is offered. Tiny amounts—perhaps a few molecules—are enough for them to sense, and John Todd told a Boston audience that he believes this sense can guide alewives and eels home to their parents' landfalls from thousands of miles across the oceans; tiny amounts of other chemicals such as P.C.B.'s and D.D.T. might be enough to interfere.

the Woods Hole Oceanographic Institution, for the Woods Hole Associates.

He is especially interested in the changes in marine communications and the responses to them caused by human activities. What effects do oil and D.D.T. and trash in the seas have? Might these be blocking those communications that are chemical? Could this prevent reproduction of a species?

The eel, for example, migrates as an adult from tiny streams and rivulets all over Europe and North America to mate in the Sargasso Sea. It dies there, and its young travel back to the landfalls of their parents. It is possible, Dr. Todd said, to train an eel to respond to only one or two molecules of a scent in its nose—a strength equivalent to diluting one teaspoon of a substance into Lake Superior. By this sensitivity, he thinks, the young eel finds its parents' home.

Salmon show the same equally remarkable abilities to distinguish their home streams; so do the herring (alewives) more familiar to Cape Cod and Woods Hole, which have been studied intensively by Dr. Todd. Some of the streams between which they choose are only a few miles apart.

His group intercepted herrings ascending the Bourndale River, trucked them to the laboratory, and put them in an artificial stream whose upstream end branched to offer the fish a choice.

The alewives refused to swim upstream at all in well water. But when water from their home stream was coming down one of the branches, they eagerly traveled up, most often up the correct branch. "This was proof that the homestream water contains a 'chemical fingerprint'," Dr. Todd said.

The next step is to find what chemicals make the fingerprint, and then to find what other chemicals may interfere with its reception. This research has overt benefits for man: Can we contemplate making synthetic messages, so that an oceanside farmer, for example, might send fish to sea knowing they would return home?

There are other messages just as fragile: that from a female lobster to a male as they court—for once, cannibalism ceases; those among the four species of Bathygobius, a tropical fish, by which each knows the two it cannot mate with.

"Out of this search for meanings in the lives of a few of the ocean's creatures," Dr. Todd said, "there has developed in each of us involved in this research a deep motivation to speak and act in some small way on behalf of the fragile oceans." We cannot study the sophisticated, lovely song of the whale when it no longer lives. We want to study the messages of the eel unchanged by human interference. —*J.K.*

Viruses With Baggage

Almost two years ago, several molecular biologists simultaneously found a new and startling enzyme, reverse transcriptase—also known as RNA-directed DNA polymerase. That more complex name means that the enzyme can make a DNA copy of a portion of an RNA molecule; which is the reverse of the process that occurs in the normal "reading-out" of genetic information from the DNA in which it is stored (*see* Technology Review *for December 1970, pp. 54-55*). David Baltimore, Professor of Biology at M.I.T., who shared in the original discovery, described this spring to an American Cancer Society seminar at Clearwater, Fla., what he and the others have done with their new enzyme since then.

Chiefly, they have found reverse transcriptases in a group of viruses called RNA tumor viruses, which are found in various animal tumors and contain no DNA, only RNA, to convey their genetic information. The question had been: How could these viruses transfer their genetic material to influence the growth of the tumor, if indeed they did? Reverse transcriptase has provided the answer, and, Dr. Baltimore said, since then there has been "a veritable explosion of interest" in how the viruses grow and communicate.

Other viruses depend upon the host cell's enzymes to effect the copying of their genetic material—enzymes that can copy from DNA, but not from RNA. The RNA tumor virus carries reverse transcriptase to supply its own special need. Thus equipped, it could —like other viruses—become part of a cell's genetic material by joining onto one of its chromosomes, and act like just another cellular gene, even though it consists of a material of a different kind from the rest of the chromosome. "Such a process would blur the distinction between what is cellular and what is viral," Dr. Baltimore said.

By tracing (with radioactive components) from the viral RNA the DNA copy that the enzyme makes, Dr. Baltimore explained, biologists can watch the virus's path of influence—whether it multiplies in a cell or whether the cell reproduces only part of the viral genetic material. And the existence of reverse transcriptase in a cell can be evidence that it contains the virus. (If the enzyme is found in normal as well as cancerous cells, it will mean that information can travel in normal cells in reverse—but for what purposes, and when?)

Dr. Baltimore's own laboratory just reported in *Nature New Biology* (235: 163-7) that reverse transcriptase from

one tumor virus, the avian myeloblastosis virus, will transcribe messenger RNA from a normal cell, a rabbit blood cell, to produce a bit of DNA.

Messenger RNA is the intermediary which carries a production order from the cell's DNA out to its assembly lines. The RNA Dr. Baltimore used directs the manufacture of globin, the protein part of the hemoglobin molecule. (Hemoglobin carries oxygen in the blood.) The DNA produced is apparently the same as that from which, ordinarily, the messenger would have obtained its message—i.e. "the critical portion of the gene for hemoglobin." Dr. Baltimore insists that "a number of technical questions remain about this work before we can be absolutely certain." But, he says, "it seems inescapable that the reverse transcriptase offers the possibility of synthesizing specific genetic components." He described the power as "awesome."—*J.K.*

TRANSPORTATION

Sometimes a Wet Noodle

Automation is the single most important tool now available in the U.S. for improving transportation. This, said Robert H. Cannon, Jr., at an M.I.T. Lincoln Laboratory seminar early this spring, is the way to capitalize—at least in the short term—on our existing systems, enabling them to yield better service at least cost.

But the Department of Transportation (of which Dr. Cannon is Assistant Secretary for Systems Development and Technology) is not putting all its eggs in this—or any other—basket, he said, as he outlined a five-point research and development program in which automation plays a central role:

☐ Air traffic control improvements, chiefly (for the next two years) to add aircraft identification and flight data to each air traffic controller's display. Identifying the "blips" on the oscilloscope and keeping track of which plane is which, having interrogated each one, is still the traffic controller's responsibility, and Dr. Cannon regards it as one of the more enervating features of the job. The new ARTS-3 system is now in operation in Chicago and will gradually be extended to 33 airports by 1973; but it will be turned off after 9:30 p.m. so that air traffic controllers don't lose their skill at handling their present data system—in case the new one fails.

☐ Harbor traffic control, based on the same principles as air traffic control. The need is made clear by several incidents—notably the one involving two tankers in San Francisco Bay in 1971.

☐ Freight car identification and location systems. The location of thousands of U.S. freight cars is unknown at any one time, Dr. Cannon said, and some simple surveillance and information-handling plan ought to reduce markedly the waste this causes.

☐ Highway improvements, to bring motorists better information about traffic conditions and to automate traffic control devices more efficiently. Such plans, said Dr. Cannon, are the way to get more highway capacity without pouring more concrete, and the U.S. is already "pouring one mile of concrete an hour," he said.

☐ Vehicle monitoring, particularly of buses, to help drivers maintain headway and tie operations more accurately to demand.

In addition—and despite Dr. Cannon's emphasis on improving existing transport systems—D.O.T. research and development funds are being invested in such exotic projects as very-high-speed air-cushion and magnetically levitated trains, studies of the effects of supersonic aircraft on environmental quality, dual-mode vehicles and other personal rapid transit concepts, and vehicle safety devices.

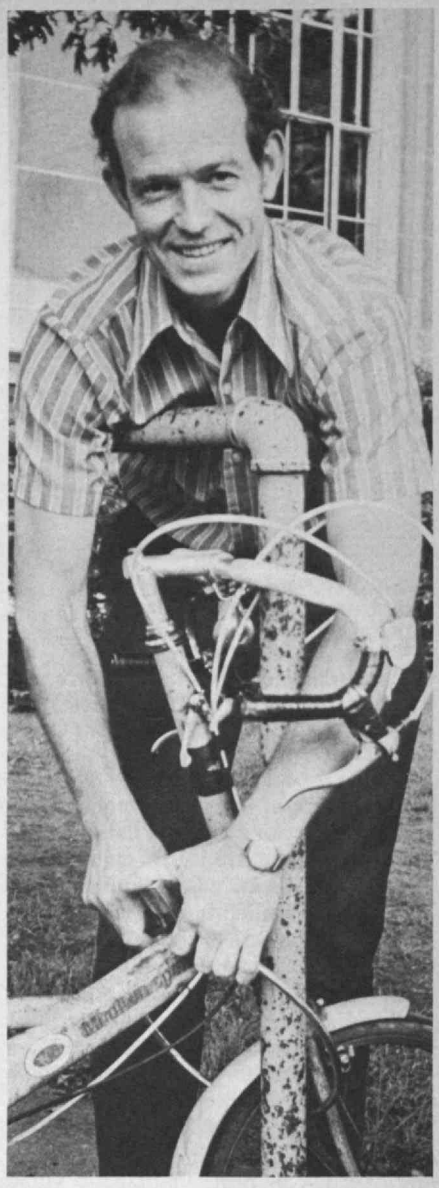
Will all this really make a difference? Yes, Dr. Cannon thinks—but we need some patience. Remember that the Department of Transportation is only a persuader and catalyst, working with existing entrepreneurs. Its best leverage is in its management of the $5 billion highway trust fund and a new $1 billion urban transit fund; but even with such inducements, said Dr. Cannon, he sometimes has "a feeling of pushing on a wet noodle when we want something to happen."—*J.M.*

Avaunt, Foul Thief!

Only one who owns a bicycle can know the frantic sense of vulnerability that comes when he must leave it, with however sturdy a chain around it and a tree, in a public—or, worse yet, unpublic—place. Bicycle thieves are ubiquitous, fast, and clever. The threat they present is one of those trivial worries that changes considerably the daily pattern of one's life.

Clearly the country needs a simple, lightweight, inexpensive, and thief-proof bicycle lock; the market ought to be in the tens of millions. The only competition is a 20-lb. chain and lock that is made of case-hardened, tempered, ⅜ in. to ½ in. steel links and costs about $20. It probably outweighs the bike.

Two candidates have emerged in Cambridge. One, offered by three M.I.T. seniors, consists of two bowed rods (see picture) of a tool steel alloy that is hardened throughout (instead of only on the surface or case) and is harder than whatever tool can reasonably be used against it. Its inventors have a collection of bolt cutters that have broken against the new lock. Dennis Intravia, co-designer with Wesley Grandmont and Tom Lydon, told the *Review* that the steel was originally made for one of the government's special needs, and is so hard that it broke the trio's first metal-bender. After the rods are shaped and joined, they receive a heat treatment that makes them not only invulnerable to bolt cutters but also to hacksaw blades, a tough prospect for tungsten carbide blades,



After his fourth bicycle was stolen, Professor David G. Wilson of M.I.T. applied his engineering talents to the design of a superior bicycle lock. The result is a tool steel rod ¼ in. in diameter, and now it is the padlock—not the chain—which is the weakest link.

The jointed steel rod and padlock shown above is a simple answer to an aggravating and common problem—bicycle thievery. As Dennis Intravia, Wesley Grandmont and Tom Lydon show, it secures the frame and both wheels to a tree and is invulnerable to all but lock-pickers.

and perhaps an impossible one for a portable acetylene torch. The alloy and the treatments are still secret, and Messrs. Intravia, Grandmont, and Lydon have applied for a patent.

"The Stopper" will be marketed as soon as its inventors can complete manufacturing and distributing arrangements—and make a padlock of the same steel, so that a thief will have to pick the lock to take the bike. They guess the price will be about $20; they hope for half that. The steel itself is expensive—$1400 per ton—and the unit uses 4½ lb. of it.

Necessity goaded David Wilson, Professor of Mechanical Engineering at M.I.T., into designing his lock. Six years ago his fourth bicycle was stolen. The lock protected his fifth until last May, when a slightly different model proved to have one flaw. (He keeps his sixth bike in his office.) His entry is also made of a tool steel alloy, in a bent rod shape. (See the picture on p. 57.) He believes that a 3/16 in. to 1/4 in. rod—one-half the diameter of "The Stopper"—will suffice, which permits a different design, a cheaper price, and a lesser weight (½ lb.). The lock encloses the frame and rear wheel and a tree; the ends of the rod are straight and notched to feed into a padlock. The vulnerable place is again the lock, but he is looking for one that will at least not allow the rod to be pulled from it. His model, he said, is firm against almost all bolt cutters and hacksaws and a problem to a torch.

Again, a patent is applied for; the lock might be nationally available in September, and should sell for $5. Dr. Wilson is also designing new bicycle racks, to which a rider can lock his frame and rear wheel or the frame and both wheels (if the rack accepts only a front wheel, the rider comes back to find only his front wheel.) He hopes that these will also be made and sold nationally.

Until either lock arrives in nearby stores, Dr. Wilson advises placing the chain on a bike as high as possible, so that at least a thief cannot use the ground to support one arm of his cutters.—*J.K.*

Urban Vehicles: Absorbing Work

A very miscellaneous group of prototype automobiles will appear at the General Motors Proving Grounds at Milford, Mich., on August 9. They will be the brainchildren of 84 teams of students at 76 universities; each will represent the team's best try at designing the perfect automobile for city driving.

The power plants will range from the commonplace to the exotic. There will be electric cars, electric hybrids (electric propulsion with an on-board engine to recharge the batteries), external-combustion engines, piston internal-combustion engines, Wankel internal-combustion engines, and maybe even a superflywheel. The cars will use not only low-lead gasoline, but also propane, natural gas, and even hydrogen. And the safety features will run the gamut of those already proposed and include at least one new one. While large pieces of production cars will be recognizable in most of the entries, some of the more ambitious teams have built their cars virtually "from the ground up."

The event will be the Urban Vehicle Design Competition (*see* Technology Review *for June, p. 68*). Intended as an educational experience for its participants, it challenges the students to build a car that will be clean, quiet, convenient, maneuverable, safe, and cheap. Objective measures of performance, along with scores assigned by judging panels (including one which rates the amount of original design work the students have done), will be compiled and weighted to pick which teams win.

Early last May 160 of the participants found time between studying for final examinations and working on their entries to attend a U.V.D.C. symposium at Catholic University in Washington. There were presentations on pollution and safety by transportation professionals and numerous workshops where the students could compare notes with professional engineers working in various fields relevant to the competition. There were also presentations by several of the entrant teams themselves; this was the main attraction for many who, like the University of Delaware's John Stewart, came to "talk with other teams . . . and see where we stand."

☐ Mr. Stewart, a senior, heads a team of about 50 students who have been working since September to design and build the Delaware car. Like many of the more ambitious entries, Delaware's is the subject of an engineering design course which students take for academic credit. And like most of their competitors, the Delaware students believe that the competition will be won by a small car. At 850 pounds, their three-wheeled entry is small—but within that weight is a formidably protective frame. The power source is a 450 cc. motorcycle engine and the car features destructable urethane foam bumpers.

☐ Cornell's electric car is one of the few entries to trace its ancestry to the 1970 Clean Air Car Race. Since then, explains team captain Geoff Hanshaw, the work has been basically "cleaning up and regrouping." The heart of the car, the electronic controller which regulates the power for the electric motor, is the proven model from before. The car this time is a modified Renault with a Volkswagon rear end and automatic transmission.

☐ At the University of Michigan, student designers have produced what must be the fanciest custom body in the competition; they used almost the same techniques as the Detroit professionals—but on a mini-budget. Their lightweight car (1,400 to 1,500 lbs.) features a protective roll cage with built-in seat frames and head restraints. Safety has been a primary consideration in this design from the beginning. The bumpers, for example, are of resilient urethane foam with steel cores; not only will they protect the car, but also they will be soft to protect the rest of the world. The power is from a single-rotor Wankel engine with an exhaust treatment system.

☐ Most of the entries are not so elaborate as Michigan's. Many, like the University of Maryland's Rankine Cycle team, are concentrating on certain aspects of the problem and relying on "off the shelf" components for the rest. In May, that team was "still breadboarding" its propulsion system (an external-combustion system using freon as working fluid). As soon as the propulsion systems were ready, reported team captain Ken Cook, they would "stuff it in some stock vehicle."

☐ Joe Finegold of U.C.L.A. reported that his team has solved many of the problems of hydrogen-fueled internal combustion engines (*See* Technology

Review *for October/November, 1971, pp. 71-72*). With a very lean mixture and exhaust gas recirculation, an automobile engine with only minimal modifications can run smoothly on hydrogen and still produce virtually negligible amounts of pollution. (And hydrogen, Mr. Finegold claims, can be an even more economical fuel than gasoline.) Preignition, backfires, and formation of oxides of nitrogen are the problems that are solved; the remaining problem is hydrogen's bulkiness, even when in liquid form. Research into thermally unstable hydrides which store hydrogen chemically combined with other substances has still not borne fruit; nevertheless, Mr. Finegold said "we are sure that will be the way of the future."

□ Peter Talmadge of Tufts reported one of the more novel bumper designs: two boards separated by old beer cans. Crushing the cans absorbs enough energy to stop a 1,500-pound car; eight cans stop it at five to six mph and twelve will stop it at up to about 12 mph. When someone speculated on the effect of extrapolating to 100 cans, one of the others chuckled, "not only that, but after all those beers, you'd have the whole team climbing in to test it!"

There was a camaraderie at the meeting which was borne of mutual interests and mutual problems. Building a car is not easy. Michigan's Rick Beer said "sometimes it's tough to keep going; there's lots of work and very little recognition." And C.C.N.Y.'s Istrate Ionescu noted another frustration: "Only about two per cent of this is design; the greatest part is administrative work."

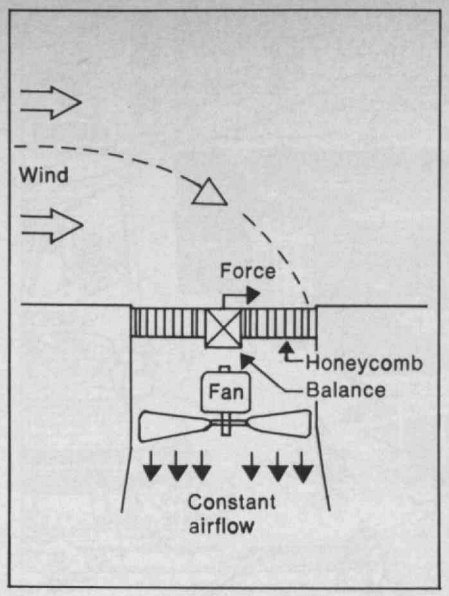
Money is another problem. George Flint, a senior at M.I.T. and president of Student Competitions on Relevant Engineering, Inc., the organization sponsoring the Urban Vehicle Design Competition, reported at the meeting that many of the grants he had sought had not come through. So the teams have had to rely for the most part on what they could find for themselves—with varying luck.

But though the work is hard and the financial conditions less than ideal, the students' dedication proves that the work is absorbing. The many faculty advisors at the May meeting agreed with Mr. Flint that "our educational objectives have been met."—*R.A.*

PHYSICAL SCIENCE

Measuring the Wind

Force, Newton stated in his second law, is equal to change of momentum; and when the wind exerts a force against an obstacle, that force measures the rate at which the wind gives up its momentum. Now Wallace E. Howell, a consulting meteorologist whose weather career began in M.I.T.'s Meteorology Department in the late 1930s, has turned Newton's equation end for end, devising what he calls a momentum anemometer that extracts the momentum from a constant stream of air diverted from the natural wind and measures the force that it exerts on a honeycomb in which the horizontal momentum of the wind is expended.



A "momentum anemometer" invented by Wallace E. Howell measures the wind by diverting a sample of it from horizontal to vertical and measuring the horizontal components of force generated in the process.

In more descriptive language, Dr. Howell's new anemometer somewhat resembles a short length of vertical stovepipe into which a fan sucks a constant stream of air. In the mouth of the stovepipe is a honeycomb through which the indrawn air must pass and from which it emerges vertically, at right angles to the wind direction, deprived of all its horizontal momentum. The honeycomb is mounted on a force balance, the electrical signals from which are resolved into north-south and east-west components linearly related to the wind.

Dr. Howell told members of the American Meteorological Society at this spring's Second Instrumentation Symposium that his anemometer "is sensitive enough for a dying zephyr and rugged enough for a super-hurricane, has a response distance but a fraction of the best conventional anemometers and to boot can measure the vorticity of the air sucked into a thunderstorm, a stunt not approached by any previous anemometer." Indeed, he told the A.M.S., his first experimental momentum anemometer "stands as the genotype of a new class of instruments with unique properties and capabilities."—*J.M.*

Physical Chemistry: A Declining Science

Believers in something called the breakneck pace of technical change would have been surprised by Professor Robert C. Reid of M.I.T.'s Department of Chemical Engineering at an M.I.T. Industrial Liaison seminar on "Chemical Process Systems Analysis."

Professor Reid's starting point was the problem that faces the designer of an industrial chemical process, when he sets out to discover the physical properties of the fluids he wishes to use—their viscosities, thermal conductivities, diffusion rates, vapor/liquid equilibrium curves (V.L.E.), enthalpy and so forth.

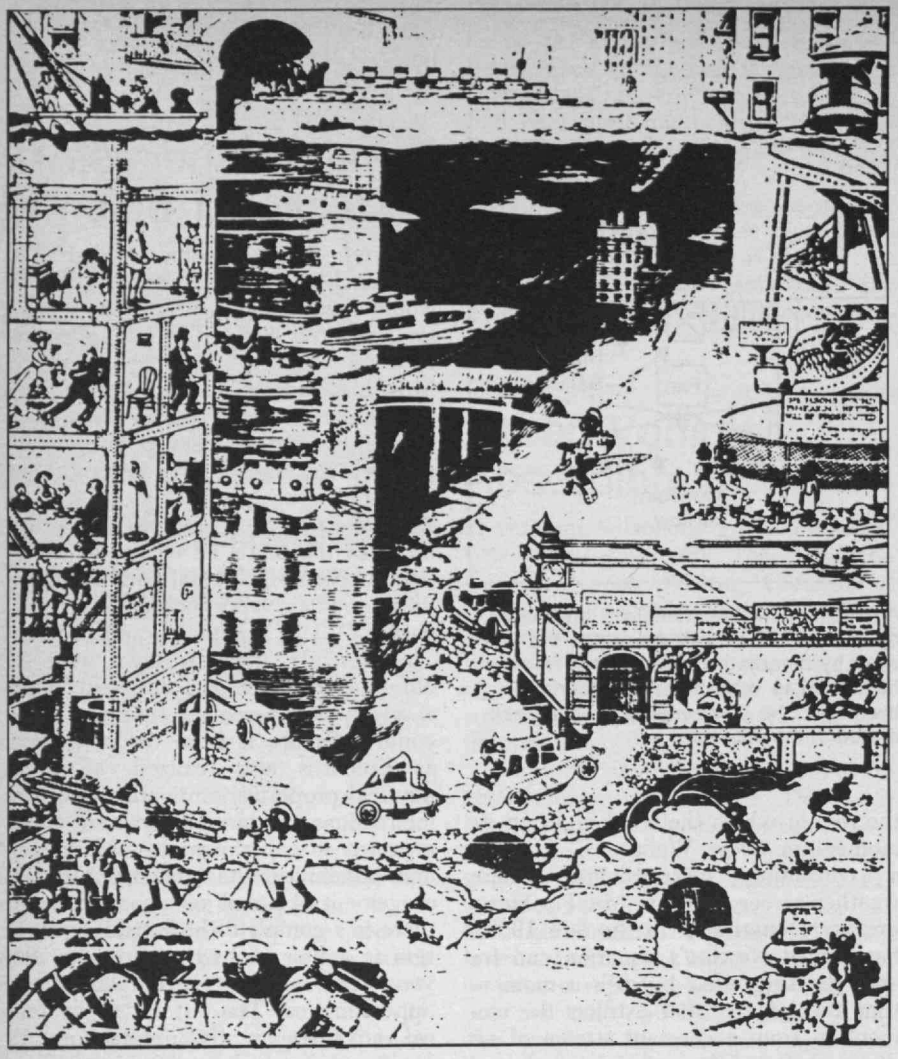
In principle, there are two ways of obtaining this essential design data for a given substance or mixture: one could calculate it from theory (since, as Epicurus also realized, all these physical properties must arise from the interactions of atoms) or one could measure it experimentally. As to the first possibility, the most complex arrangement of atoms of whose behavior there is a complete theoretical explanation is a pair of hydrogen atoms. Beyond that, all is over-complexity and approximation. The last major theoretical advance on the interactions of atoms occurred about 40 years ago—London's "dispersion forces." The most frequently needed physical property (V.L.E.) is one of the furthest from being calculable.

Empirical data are being gathered at a diminishing rate. Graduate students, explained Professor Reid, are not interested in such tedious and apparently routine work; funding it is difficult; and data obtained by chemical companies for their own designers tend to remain proprietary. The rate of useful publication seems to be slowing down.

Professor Reid is clearly not exactly in a state of future-shock; but he does express a certain amount of past-shock. Current, respected reference sources, he finds, contain a high proportion of figures which have never been checked since they were obtained, by the crudest techniques, a century or more ago.

So, in practice, the designer learns the art of extracting a picture of the situation which interests him from a collection of dubious data points and some equations which are both complicated and approximate.

When this editor expressed his appreciation of Professor Reid's talk, the reply—true to the state of the art—was "Why? I didn't say anything!" —*F.W.*



This view of the possibilities of future submarine technology—the classic "cities-under-the-sea" vision—is 60 years old this year: It was the cover of *Life* on January 4, 1912. The original is now owned by Professor Ira Dyer, whose critical assessment of twelve fields of marine activity is that only four now offer significant growth potential for new technology: fossil fuels, non-fuel minerals (sand and gravel, mainly), military systems—and environmental protection.

OCEANS

Where's the Action?

The dream of a utopian future under the sea has been with us for a very long time. In the 1960s, in particular, there were great hopes for ocean engineering and industry, to which reality did not measure up. So when Ira Dyer, Professor of Ocean Engineering at M.I.T., discussed his field of work at the alumni seminar on "Technology and the Economy in the 1970s" in Boston it was with conscious caution.

Out of a list of twelve ocean-related fields of activity he selected just four as areas of opportunity for technology-based business and employment in the U.S.: fossil fuel winning, minerals (sand and gravel, rather than metals), defense, and the protection of the ocean environment. These were the areas in which one could expect both appreciable growth and a real impact from new technology.

As to the others: transportation, coastal-zone development, waste disposal, and recreation, he said, are all growth areas, but not fields in which new technology is likely to make a very significant difference. Oceanography is certainly a high-technology activity, but in terms of budgets and manpower a small and stagnant one. The same applies, Professor Dyer thought, to the business of turning salt water into fresh. Tidal power generation, although there is a system working in France, is clearly not being backed in the U.S. —and if it were, it could be done with fairly crude technology.

This leaves only fishing: in the U.S., a stagnant industry, using old techniques and with little to hope for from new ones, even in principle. Conceivably, of course, said Professor Dyer, priorities could be redirected and the fishing industry could be deliberately stimulated, but this is not going to happen. In New England a few venturesome groups are making good profits from fishing with 110-ft. vessels, which cost about $1 million each and which the traditional family concern cannot afford. Even so, there is no rush to invest, because it is widely realised that the fish resources of the oceans are already being exploited close to their ultimate limits.

Inevitably, this leads to the notion that the days of "hunting" fish may be over, and the future lies with farming them. And indeed, the annual world fish-farming yield already exceeds the total U.S. sea catch. But fish-farming, like land-farming, is economic only at a certain level of cost per acre, and in certain climates. Israel is able to export land-grown fish, but Professor Keil did not see mariculture as becoming important within the U.S. in the next ten years.—*F. W.*

Ocean Technology Coming Ashore?

It was 20 years ago, just after World War II, that oceanography began coming of age. Since then, oceanographic engineering—electronic and otherwise —has gradually been catching up. Now the question is, when will we start bringing ocean technology ashore?

Less than a decade ago, the best insulated wire obtainable came with an average of six pinholes through the insulation per 1,000 ft. Now, said James M. Snodgrass of Scripps Institution of Oceanography at the annual meeting of the Institute of Electrical and Electronics Engineers early this spring, you can take insulated oceanographic wire off the spool without giving it a second thought.

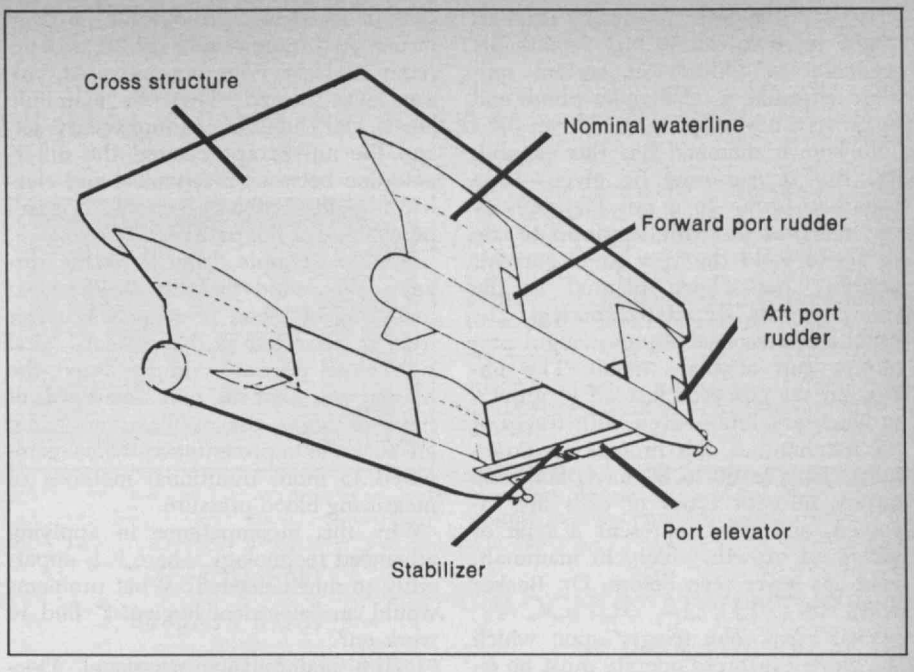
After uncounted instruments had been lost to sharks who mistook their cables for food, oceanographers and engineers collaborated to discover that a shark can exert a force of 380 kg. over the area of his tooth—i.e., a pressure of many tons/sq. in. Cables are more resistant now.

Insulated wire dragged through the ocean used to be stripped of its insulation—by fish; as it turned out, they were attracted by bubbles of air due to cavitation. Reshape the wire to eliminate the cavitation and the insulation is left intact.

Still oceanographers have their chronic problems for engineers. When an engineering device fails at the end of a 10,000-ft. cable, oceanographers can be pardoned for wanting better quality control. When manufacturers change minor product specifications without warning so that once-tight seals leak, oceanographers think their complaints not unreasonable.

The troubles are mostly in mechanical engineering, agreed Allen C. Vine, Chief Oceanographer at Woods Hole Oceanographic Institution (for whom the submersible *Alvin* is named). And this is curious, for undersea conditions are really not that bad: working pressures rarely more than 8,000 lbs./sq. in., which is low in terms of most material properties; temperatures within a very few degrees of 0°C.; currents normally only a few miles per hour.

The real problem, said Dr. Vine, is that "we're still taking land technology to sea. Ocean engineering will have come into its own when we start taking ocean technology ashore." What did he mean by that? Simply that—to give one example, where ocean technology is already ahead—the ignition system of a car is "far more allergic to moisture than the electronics we send to the bottom of the sea."—*J.M.*



This Semi-Submerged Ship (S^3) is being studied in model form at the Naval Undersea Research and Development Center. It offers a combination of high speed and a smooth ride which is of special interest in oceanographic research and modern warfare.

Avoiding the Ocean Waves

The drawing shows a new kind of ship (or perhaps an old idea revived) known as the S^3—Semi-Submerged Ship. It was conceived in 1968 at the Naval Undersea Research and Development Center, San Diego, Cal., and its development has now reached the point where a 190-ton vessel has been designed and an 11-ft. model of it tested by the San Diego group.

The original need was for a small ship to provide support for an unmanned submerged vessel. It had to travel as fast as a large navy ship in rough seas while providing a steady platform for sonar. The S^3 configuration was tested as a 5-ft. towing-tank model, and now appears to have a long list of virtues, summarized at the 1971 winter meeting of the American Society of Mechanical Engineers by T. G. Lang of the Center.

Compared with conventional ships of the same displacement, he said, the S^3 offers much better seaworthiness at all speeds, greater speed and maneuverability, the possibility of sudden bursts of high speed, greater propulsive efficiency, more weight-carrying capacity and deck-space, and "improved sonar, towing, aircraft handling, and weapon-launching capabilities." In most sea states, said Dr. Lang, the S^3 offers "near-level flight" with the help of its hydrofoil control surfaces (note, in the drawing, the aircraft-like aft stabilizer and elevators and the forward canards).

Dr. Lang acknowledged that semi-submerged ships have a long history. A single-hulled version was patented in 1880 and a multiple-hulled design in 1929. In very recent years, ships rather like the S^3 in their basic layout have been proposed by a number of people, including some M.I.T. students as part of a class project (concerned with ocean mining). But Dr. Lang claims originality for the S^3 control surfaces and—an option for high sea-states—the automatic system that would drive them. The speed of the S^3 should reach 45 knots.

Displacement would be in the range 100-15,000 tons. Design efforts are presently focussed on a 3,000-ton version. Personnel and weapons are assigned to the over-water part of the ship, leaving the submarine hulls for fuel, motors and ammunition. Dr. Lang named four possible disadvantages: the large width and draft, a problem in docking; high structural weight in relation to total weight; and the problem of trim when at rest. He did not suggest that the S^3 might have a civilian market. The notion that a high-speed non-spill cruiser could be an ideal pleasure-craft drew from one M.I.T. naval expert the observation that there did not seem to be that kind of money around these days. —*F.W.*

BIOENGINEERING

Bone Electronics

Today's most urgent field of bioengineering study, thinks Dr. R. O. Becker of the Veterans Administration Hospital, Syracuse, N.Y., could be the role played by electrical forces in the growth and development of living organisms. Application is outrunning understanding.

A recent discovery concerns the growth of bone. Bone consists of collagen—long-strand molecular material—and mineral. The first stage in Dr. Becker's work on electrically stimulated bone healing, he told the annual convention of the Institute of Electrical and Electronics Engineers in New York this spring, was the discovery that mechanical stress between the two components of bone results in a tiny electric potential. He guessed—and presently confirmed—that this was involved in the mechanism by which bone restructures itself to be strongest at points of greatest strain. Bone has piezoelectric properties: mechanical strains give rise to small voltages.

From here it was a simple matter for Dr. Becker and his associates to discover that tiny electric currents—500 micro-microamperes—promote healing of fractures, which are normally characterized by naturally generated, highly nonuniform electrical fields. But the mechanism whereby electrical activity assists in the repair of fractures turned out to be totally unpredicted. Certain blood cells, accumulating at the point of injury—those apparently preprogrammed to perform repair functions—are somehow induced by these tiny electrical forces to quickly transform themselves into more primitive cells with the options of becoming cartilage, then bone.

From here it was another easy step for Dr. Becker's group to guess that

micro-microampere electric currents might be involved in the remarkable regenerative abilities of certain reptiles: amputate a salamander's limb and he grows a new one.

No known mammal has this capability. But it can now be given—in a primitive form—to a rat. Platinum-silver electrodes (with appropriate resistors to yield the very small currents desired) have been planted in the stumps of rats' amputated forelegs. The usual amputee heals by growing a protective cap of bony tissue. The implanted rat proceeds instead to grow a rudimentary limb—even with traces of the forehand if the process continues for as long as 60 to 80 days. Some 20 to 25 different types of cells are involved, and they represent a type of biological growth which, in mammals, man has never seen before, Dr. Becker said.

What next? The trigger upon which the electrical forces operate must be on the surface of the cell. Whatever the processes, they can hardly be envisioned as simple. And our vision is limited by our almost complete ignorance of the physical, chemical, or electrical characteristics of the cell surface.

Even while these questions are the subject of research, the empirical findings to date will be translated into clinical practice. Dr. Becker urges that both issues be considered together, that we have here a new field—electrical physiology—worthy of a national effort.—*J.M.*

Electrical Hygiene: A Hospital Need . . .

Medical electronics—the use of electronic instruments in clinical care—is "one of the real growth industries of our time." But engineers who design the new machines for hospitals—and those who try to help doctors and nurses use what has been sold to them as labor-saving and life-saving bonanzas—are worried: instruments are often misused, and no one knows for sure how many patients' lives have been endangered.

Now that we have medical electronics, we also need "electrical hygiene," says Allan F. Pacela, Chief Research Scientist at Beckman Instruments, Inc.

Dr. Pacela was among a score of engineers and doctors speaking at a special seminar on Engineering in the Hospital at the annual convention of the Institute of Electrical and Electronics Engineers in New York early this spring.

Dr. Joseph M. Civetta of Massachusetts General Hospital reported on a recent M.G.H. survey: only 30 per cent of its electrocardiograph monitors in use at the time were calibrated correctly. "Alarms were not activated, volume was turned down to inaudible levels, rate limits were improperly set, and the nurses appreciated the differentiation between mechanical and electrical cardiac activity in only a small percentage of the patients."

Another example, from the same survey: "We found that the oscilloscopic rendering of blood pressure was never used or recorded as the patients' 'vital sign' blood pressure. Simply stated, the reason was that in only one-third of the cases was the oscilloscope giving an accurate representation when compared to more traditional methods of measuring blood pressure."

Why this incompetence in applying advanced technology where it is apparently so much needed? What problems would an "electrical hygienist" find to work on?

☐ Hire maintenance personnel. Doctors and nurses can hardly be expected to learn electronics; "16 hours a day seven days a week there is no one in our hospital who knows electronics," Dr. Civetta said. A rule of thumb from Herbert E. Goldberg of American Optical Corp.'s Medical Division: if a hospital has an electrician, it should also have an engineer.

☐ Buy carefully. Let hospital administrators resist the temptation to buy one of everything so as to have every new gadget on the market.

☐ Standardize equipment. Dr. Civetta showed a photograph of scores of spaghetti-like varicolored leads lying across a hospital bed: the connections to all the different electronic devices available in a single hospital recovery room. Given so many different colors and connectors, Dr. Civetta thought it "remarkable that only one out of five machines is incorrectly connected."

☐ Make machines easy to use. Doctors do not read their mail and have no time for salesmen, and nurses cannot (or will not) try to understand most instruction books. Each machine has its own set of controls, unlike those of any other; you cannot tell how to calibrate or operate the next machine simply by knowing how to run the first one. According to Dean O. Morton, General Manager of its Medical Electronics Division, Hewlett-Packard spends twice as much time helping hospital personnel learn to use an electronic machine as is needed by industrial users of a similarly complex device.

☐ Resist unnecessary complexity and innovation. Let instrument makers emphasize basic usefulness and resist the engineers' urge to "re-invent everything." Medical electronics is a fast-growing, competitive industry in which some 50 manufacturers are scratching for a share of a $50 million annual market; innovations—fundamental and superficial alike—are likely to be emphasized. "We have to admit that engineers are always going to invent and salesmen are going to seek every advantage from every restyling," said Mr. Goldberg; and this, he said, leads to a "wild scramble for the latest technology."

Has the invasion of hospitals by electronics saved money? Probably not, said Mr. Morton, and he notes that so far only 10 per cent of U.S. hospital beds have been equipped with electronic monitors of any kind, and the average cost per bed has been about $2,000. This will soon rise to $4,000, said Mr. Morton, because machines will be better and their services more comprehensive.—*J.M.*

. . . And a Solution

When hospital electronic equipment is calibrated incorrectly or breaks down altogether, patients' safety is obviously endangered. But even "perfect" machines can be fatal.

For example, said Gordon Friedlander in the September, 1971, issue of *I.E.E.E. Spectrum*, the bed-ridden patient who must wear implanted electrodes for heart-muscle monitoring can be electrocuted by "microshock"—the highly localized effect of small, normally harmless leakage current from electrical devices. Currents as low as 50 microamperes (imperceptable when applied externally) can cause an uncontrolled and fatal contraction of the heart muscle.

For protection, Mr. Friedlander emphasizes, patients with implanted electrodes must remain isolated from line voltage; but maintaining this isolation is difficult if the patient requires several interconnected machines. To solve the problem, Dr. W. E. Gilson of Gilson Electronics, Inc., has been testing an optically-powered transmitting-receiving system which electrically isolates the patient fully.

A sender attached to the patient contains photocells which receive light from long-life bulbs to produce electricity. The current from the cells powers a short-range radio transmitter; a receiver picks up the signals and sends them to displays or recorders. Although the receiver operates from line voltage, leakage to the patient is impossible.

Isolated, radio-transmitting medical instruments are among the innovations often cited as "space spin-offs." But Dr. Gilson's work is independent of N.A.S.A. or D.O.D. "The solar cells used were probably pushed to a higher efficiency as a result of the space program but have been available for decades."—*Michael Chiusano*

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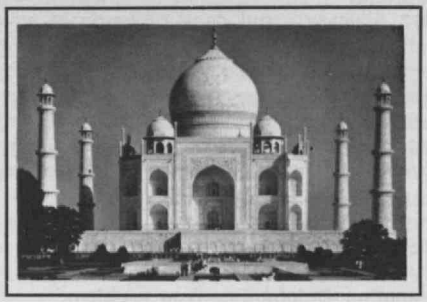

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An unusual opportunity to view the outstanding attractions of India and the splendors of ancient Persia, together with the once-forbidden mountain kingdom of Nepal. Here is truly an exciting adventure: India's ancient mounuments in **DELHI;** the fabled beauty of **KASHMIR** amid the snow-clad Himalayas; the holy city of **BANARAS** on the sacred River Ganges; the exotic temples of **KHAJURAHO;** renowned **AGRA,** with the Taj Mahal and other celebrated monuments of the Moghul period such as the Agra Fort and the fabulous deserted city of Fatehpur Sikri; the walled "pink city" of **JAIPUR,** with an elephant ride at the Amber Fort; the unique and beautiful "lake city" of **UDAIPUR;** a thrilling flight into the Himalayas to **KATHMANDU,** capital of **NEPAL,** where ancient palaces and temples abound in a land still relatively untouched by modern civilization. In **PERSIA** (Iran), the visit will include the great 5th century B.C. capital of Darius and Xerxes at **PERSEPOLIS;** the fabled Persian Renaissance city of **ISFAHAN,** with its palaces, gardens, bazaar and famous tiled mosques; and the modern capital of **TEHERAN.** Outstanding accommodations include hotels that once were palaces of Maharajas. Total cost is **$1725** from **New York.** Departures in January, February, August, October and November 1972.

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Gold Bar Thieves

Puzzle Corner:
Allan J. Gottlieb
Department of Mathematics
North Adams (Mass.) State College

My year in California is nearly up. Next year I will be at North Adams State College, Massachusetts; by the time this column is in print I'll be enroute, so all correspondence henceforth should be sent to me at the Department of Mathematics, North Adams State College, North Adams, Mass., 01247.

Some observations after a year in the West: The East is more formal, the West more relaxed. The weather at Santa Cruz is about perfect; but to be fair the California central valley is no bargain (*very* hot, muggy summer and deep fog in winter). California drivers are better than their Eastern counterparts—unless it snows (rarely except in the mountains), when they're awful; I have a story about a lady skidding sidewise up a mountain in a VW that . . . . The California higher education system is more extensive than any back East primarily because there are so few private universities; students here seem less pressured and less competitive than were my colleagues at M.I.T., and Alice says ditto for Brandeis. The televised sports coverage here stinks—only one hockey game a week, same for basketball, baseball, etc. I hear it's better in San Francisco, but in Worcester you see the Bruins. Also, no sports radio shows to rival "Calling all Sports" or the gone-but-not-forgotten "Sports Huddle." In fact, radio programming in general can't compare with Boston's. Alice, a strong "East" fan, has reminded me about the museums back home which dwarf the ones here, and I just remember how much better Eastern public transportation is. Hair is longer and blonder here (on both sexes) and people look more active—of course the weather has a great deal to do with this.

If this rambling essay has offended more people than it's entertained . . . well, it's my column. Please send problems and solutions to me at my new address.

Problems

A bridge problem from Michael Kay:

Jy1 Given these hands:

	♠ K Q J 10 ♥ A K x x ♦ x x ♣ A x x	
♠ 9 8 ♥ Q x x x ♦ J x x x ♣ x x x		♠ A 7 6 ♥ J x x ♦ Q x x ♣ J x x x
	♠ 5 4 3 2 ♥ x x ♦ A K x x ♣ K Q x	

West leads ♠ 9; East takes the first trick with the ♠ A and returns the ♠ 7. Can South make his contract of six spades?

Neil Cohen writes:

Jy2 Let P be a prime. Can P^2 divide $2^n - 1$ when P does not divide n?

This card problem—it has nothing to do with bridge—was submitted by David Merfeld:

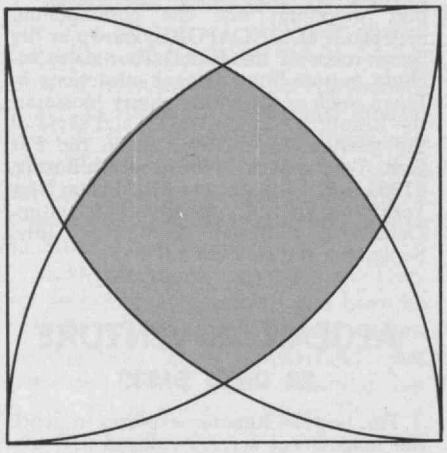
Jy3 Arrange a full deck or cards in any mixture of groups of three or more by kind or by consecutive sequence of the same suit (example: four hearts, four spades, and four diamonds; or eight spades, nine spades, and 10 spades). What is the maximum number of cards that can be left out such that they cannot be formed into groups of sequences nor added to those previously made?

John Bobbitt describes the following as "another Diophantine-type problem:"

Jy4 Seven thieves stole some gold bars. Unfortunately, when they started to divide the take it didn't come out even. But finally they figured out how to divide the bars: the first thief received one plus one-seventh of the remaining, the second man two plus two-sevenths, etc., the last man receiving seven plus seven-sevenths—i.e., all the remaining bars. In this way they didn't have to divide any bars. What is the smallest number of bars they could have stolen? And which man received the most?

A geometry problem comes from Charles Landau, who writes that it has been circulating around M.I.T. "for a while." Four of his friends solved it, each by a different method; average time was 10 minutes:

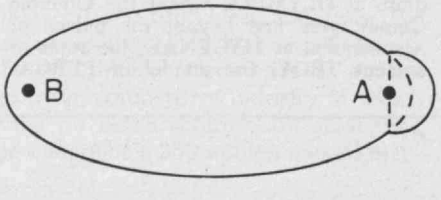
Jy5 Given a unit square with unit radius arcs drawn centered at each corner, find the exact area of the four-sided (shaded) space bounded by the arcs below:



Speed Department

Thomas F. McNally asks for the flaw in the following perpetual motion scheme:

SD1 Take a rather eccentric circular ellipsoidal shell (a = b << c) with a perfectly reflecting inner surface. Cut off one end perpendicular to the long axis through one of the two focal points. (A). Suspend two identical, small black bodies at the foci (A and B). Finally, join a perfectly reflecting hemisphere of appropriate radius to seal the open end.



Now consider the radiation and absorption of thermal energy from A and B. Half of the energy emitted by A strikes the hemisphere and is reflected back upon itself. The other half strikes the ellipsoid and is reflected to the other focus, B. Most of the radiation from B hits the ellipsoid and is absorbed by A. The fate of the small fraction of radiation (E) striking the hemisphere is not immediately clear, but for a sufficiently eccentric ellipsoid, this energy is negligible. So A receives

$\frac{1}{2}R_A + (1 - E)R_B \approx \frac{1}{2}R_A + R_B$,

and B receives

$\frac{1}{2}R_A + ER_B \approx \frac{1}{2}R_A$.

In equilibrium A and B must radiate as much as they receive; therefore, by the Stefan-Boltzman Law ($R = \sigma T^4$):

$(T_A/T_B)^4 = [(T_B{}^4 + \frac{1}{2}T_A{}^4)]/\frac{1}{2}T_A{}^4$,

$T_A = 2^{1/4}T_B$ (violating the Second Law of Thermodynamics).

Perpetual power could be obtained, for example, from a thermocouple between A and B. Even if the walls are not perfectly reflecting and A and B are not perfectly "black," it seems some free power should be obtainable.

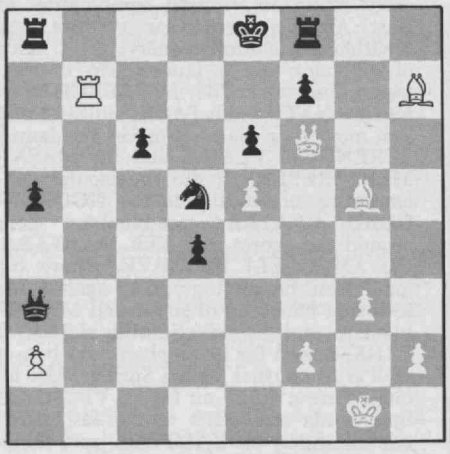
This one from Gilbert Shen should remind you of "casting out nines:"

SD2 Show that the actual number $(a_n a_{n-1} \ldots a_1)_8$ is divisible by 7 if and only if $(a_1 + a_2 + \ldots + a_n)$ is divisible by 7.

Solutions

The following are solutions to problems published in *Technology Review* for March/April, 1972:

66 Given the following, White to move and checkmate.



Captain George Martin (and other readers) pointed out correctly that the colors in the diagram as published (above) are in fact reversed; the proposer submitted a correct chessboard, which was reversed in the process of production. Captain Martin's solution:

The winning move is Q—QP (check). The replies are

A. 1. N—Q2
   2. Q—K7 (mate)

B. 1. Q—Q2
   2. R x Q (check), N x R
   3. Q x N (mate); or
   2. K—K1
   3. Q—K7 (mate)

And the Q-sacrifice, with all three attack-

ing pieces cooperating:

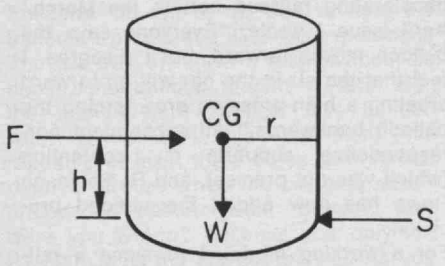
C. 1. . . . P x Q
2. B—N6 (check) R—B2
3. B x R (check) K—B1
4. B—R6 (mate)

Another complete solution came from Walter I. Nissen, Jr. Bob Baird interpreted the incorrect diagram in an unintended manner, and the following readers chose the main line for their solutions: Gerald Blum, Edward Gaillard, Harvey Greenspan and B. Ronben, Peter M. Kendall, Stewart Levin, John W. Meader, Harry Zaremba, Ben Zuckerman, and the proposer, Peter J. Meschter.

67 Three tumblers stood on a table in an earthquake; one was full, one half full, and one empty of water. After the shocks subsided, two tumblers had fallen, one was standing unaffected; which one? If each tumbler was cylindrical, 2" dia. by 6" high, of uniform thickness, weighing 130 g. empty and 430 g. full, what depth of water would give it maximum stability and what seismic acceleration would have left it erect while tumbling two others?

A controversy. Since I'm no expert, here are both sides. This minority report is from Bob Baird:

The full tumbler did not tumble. One's first impression is that the most stable tumbler is the one with the lowest center of gravity, but stability is directly related to the level of fluid. This is clear from the diagram:



A seismic force S applied is matched by an equal and opposite force F. Since the moments about the point on which S is applied must be zero, Fh = Wr. Since

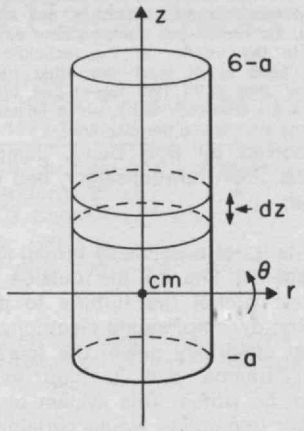
r = 1, we have
F = S = W/h.

W, the total weight, is the sum of the tumbler's weight (130 g.) and the weight of the fluid (50d, where d is the height of the fluid); h, the height of the center of gravity, is the composite of the tumbler's center of gravity (130 at 3") and the fluid's center of gravity (50d at d/2). Obviously, W decreases faster as a function of d than h does. Therefore the force required is at a maximum when d is at a maximum. Thus the more fluid there is, the greater the force required to tip the tumbler. In fact, 143.3 g. are required to tip the full tumbler. Slightly less force is required to tip the other two. The movement or spillage of fluid as the tumbler tips has no effect on the relative force required to begin the movement.

For the majority we have Allen W. Wiegner, who proposes that the partly-filled tumbler was the one still standing; his analysis:

Let t = thickness
q = acceleration due to the earthquake
r = radius (1")
h = height of fluid
H = height of tumbler (6")

and know that water weighs 50 g./cu. in. The volume of the glass is given by $2\pi rtH + \pi r^2t = 12\pi t + \pi t = 13\pi t =$ 130 g., or $t = 10/\pi$, or 20 g./in. of height plus 10 g. for the bottom.



In the diagram, consider the center of mass (cm) at the origin: it extends from z = −a to z = (6 − a).

$$\int_0^{6-a} 2\pi r\, tz\, dz = \int_0^{a} 2\pi r\, tz\, dz + a\pi r^2 t.$$

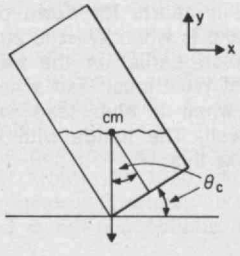
Plugging in, $2\int_0^{6-a} z\, dz = 2\int_0^{a} z\, dz + a$, or

$$z^2 \Big|_0^{6-a} = z^2 \Big|_0^{a} + a;$$

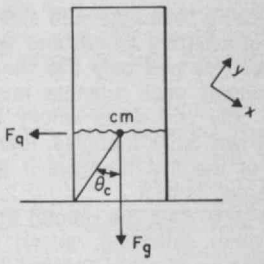
$36 - 12a + a^2 = a^2 + a$, and $a = 36/13 = 2\ 10/13"$ from the bottom, when the glass is empty. With liquid in the glass, the analysis becomes

$$\int_0^{6-a} 20\, z\, dz + \int_0^{h-a} 50\, z\, dz + \int_0^{a} 20\, z\, dz + \int_0^{a} 50\, z\, dz + 10a,$$

or $5h^2 - 10ha - 26a + 72 = 0$. When the glass is full, h = 6; $5h^2 - 10ha - 26a + 72 = 0$; and $a = 2\ 40/43"$ full. For best earthquake resistance, we seek the lowest cm. Obviously, if cm is minimum, the liquid is at the level of cm. Setting h = a, $5h^2 + 26h - 72 = 0$, and h = 2. Therefore, 2" of fluid is the condition of maximum stability.



To figure θ_c, the critical tipping angle, consider that as the tumbler tilts, cm remains in a constant position (ignoring "sloshing"). The tumbler tumbles when cm goes outside the edge of the tumbler. For the condition of maximum stability, when cm is 2", $\tan\theta_c = \frac{1}{2}$ and $\theta_c \approx 26°$; for cm ≈ 3" from the bottom (full or empty glass), $\tan\theta_c = 1/3$ and $\theta_c \approx 18°$.



For the tumbler to remain upright, the (x) component of F_g (see drawing above) must exceed the (−x) component of F_q. Or,

$F_g \sin\theta_c \geq F_q \cos\theta_c$.

Let $F_g = M_g$ and $F_q = M_q$, then

$\tan\theta_c \geq q/g$. For the partially-filled glass, $q \leq g \tan\theta_c \leq \frac{1}{2}g$. For the full or empty glass,

$q \lesssim g \tan\theta_c \lesssim 1/3\ g$.

Thus a seismic acceleration between (approx.) 1/3 g and 1/2 g would cause one tumbler to stand while the others fell; 1/2 g would tumble all but the most stable.

Voting with the majority were Winslow Hartford, Harry Zaremba, and the proposer, R. Robinson Rowe.

68 Given the number of spheres along a single edge, how many spheres are contained in a pyramid with an equilateral triangular base?

Unanimity again. The following is from James L. Fidelholtz: The base of the pyramid consists of (pick one side) the n spheres on that side, plus the (n − 1) in the row next to the first, plus . . . plus the single sphere at the apex of the equilateral triangle. The layer above that consists of the (n − 1) spheres along one side, plus the (n − 2) in the next row, plus . . . plus the single sphere at the apex. The last layer consists of the single sphere at the top. The kth layer contains a total of

$$\sum_{j=1}^{k} i = [k(k+1)]/2 \text{ spheres (easily}$$

proved by induction). Therefore, the n layers (if there are n spheres along one side of the base, and we have a regular pyramid, there must be n layers) contain a total of

$$\sum_{j=1}^{n} [j(j+1)]/2 = \tfrac{1}{2}Q, \text{ where}$$

$$Q = \sum_{1}^{n} j^2 + \sum_{1}^{n} j.$$ The first part of

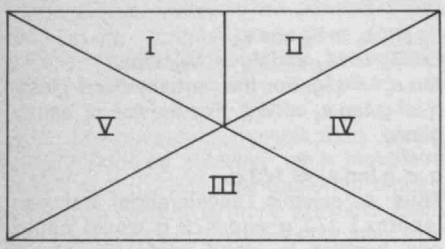
$Q = [n(n+1)(2n+1)]/6$ (again, easily shown by induction). The second part of $Q = [n(n+1)]/2$. Therefore, expanding, combining terms, and factoring again,

the total number of spheres is $[n(n + 1)(n + 2)]/6$.

Also solved by Bob Baird, Gerald Blum, H. Greenspan and B. Ronber, J. Stewart Harris, Winslow Hartford, Stewart Levin, M. Sacid Ozker, Claude Rabache, Mitchell Serota, William L. Thoen, Allen W. Wiegner, Ben Zuckerman, and the proposer, Harry Zaremba.

69 Consider a rectangle with sides a and b, each of arbitrary length and with $a \neq b$. Inscribe five and only five triangles in the rectangle; each triangle must have two and only two sides wholly in common with two other triangles. Identify the position of the five triangles if the ratio of their areas is n, $n + 1$, $n + 2$, $n + 3$, $n + 4$; $n > 0$. Find the ratio(s) and show that no other satisfying ratio(s) exist(s).

The following is from Stewart Levin:



Since the sum of IV and V equals the sum of I, II, and III, which equals the amount ½ab, we have

$(n + g) + (n + h) + (n + k) = (n + d) + (n + e)$,

where g, h, k, d, e $\epsilon\{0, 1, 2, 3, 4\}$,

$n = (d + e) - (g + h + k)$; but for this to be positive, and since $d + e + g + h + k = 10$, we have $(d + e)$ is greater than $[10 - (d + e)]$, which means that $(d + e)$ is greater than 5. But this is only possible for

$d,e = 3,4 \ldots n = 4$; and

$d,e = 2,4 \ldots n = 2$. Thus the only other possible sequence of integers satisfying this problem (in addition to 4:5:6:7:8, which was involved in **SD1** of the same issue March/April issue) is 2:3:4:5:6. Of course, this result holds only for the triangles as arranged in the diagram. I shall now show that this is the only possible arrangement satisfying the conditions of the problem:

1. No cross-corner triangles are allowed, since they could have only one side in common with another triangle; thus triangles can have a base on only one side of the rectangle (or part of a side).
2. No triangles can be wholly in the interior of the rectangle, for then it would have three sides in common with other triangles. Thus each triangle has only one and only one base on a side of the rectangle.
3. At least one side of the rectangle has two or more different triangles situated on it. This is a consequence of having five triangles and only four sides on the rectangle.
4. No side of the rectangle can have three or more triangles based on it; for if there were three or more on one side, adding at least three (at least one for each of the remaining three sides) comes out with at least six triangles where there can be only five. Therefore, at least one side of the rectangle has exactly two triangles based on it.
5. No more than one side can have two triangles on it; for then adding at least two more triangles for the two remaining sides gives the contradiction of having six triangles. Therefore, the rectangle has three sides with one triangle based upon each and one side with two triangles based on it.
6. The conditions of the problem and of no cross-corner triangles rules out the two-on-one triangles having no sides in common; therefore, they have one side in common.
7. There can be at most one point in the interior of the rectangle where vertices of the triangles meet. Since at least three triangles would have to meet at each of the points, this means that there would have to be at least six triangles, again a contradiction. This means that triangle vertices can meet at most at one place in the interior of the rectangle.
8. If the third vertices of the two-on-one-side triangles met in a corner of the rectangle (they cannot meet on the middle of an edge of the rectangle, for then the rectangle would have two sides with two triangles on them), then the triangle on the side closest to that corner would be a cross-corner triangle, which is not allowed. Therefore, the two-on-one triangles have adjoining vertices in the interior of the rectangle. This situation leads to at least two other triangles meeting at that point (the two-on-one triangles form an angle less than 180°), which immediately leads to the situation in the diagram.

Also solved by Bob Baird, James L. Fidelholtz, John Lowdenslager, and Harry Zaremba.

70 Why is it not possible to propel jets of water against fins on the outside of a turbine to propel the turbine to power an electric dynamo, create electricity, and with that electricity power the jets?

Harry Zaremba puts a stop to this machine; he writes: This system of electric power generation would certainly not be able to sustain itself. All the electrical energy would be dissipated in friction and heat loss, but—most important—a 100 per cent conversion of energy from the jets to the turbine could never be achieved due to the necessity to return the water instantly to the energy level it had before reaching the pumps. This is impossible, and the equipment would coast to a disconcerting permanent stop.

Better Late Than Never

Solutions to the following problems have been received:

51 Greg Bernhardt refuses the published solution (see *Technology Review* for May, p. 65), which he says is "erroneous in at least two places." He writes:

The most glaring mistake concerns the throw-in at the end of the hand. At this point, West has refused the spades twice and South has just taken West's ♠K with his ♠A. The remaining cards are:

West:	*South:*
♥ K J 7	♠ 10 5
♣ K Q	♥ A Q 3

South can safely lead one spade, with West discarding a club. If South leads his remaining spade, West can safely discard the ♥7 instead of the club. Then South must lose one of his three hearts to West and West can cash the club for down one. South does no better by keeping a spade—West can still lead back his club and force South to finesse himself again in hearts for down one. The other mistake is when West is put in with the ♦J much earlier in the hand. You assume that West must lead a heart from his hand when a club lead will work perfectly well. The hands with West on lead look like this:

North:
♠ 7 3
♥ 5 4 2
♦ 10 9 7

West:
♠ K 6
♥ K J 7 6
♣ K Q

South:
♠ A J 9 5
♥ A Q 10 3

South must rough the club lead somewhere. If he roughs on the board, he gives up hope of using the diamonds and must still lose a spade and heart. If he roughs in his hand and pitches his ♥2 from dummy, he is still in trouble, for West can still keep him off the board. West has a complete count of South's spades. If South leads the ♠J or ♠9, West ducks and concedes his ♠K in favor of two heart tricks, for he can still get out of his hand with a club, as explained earlier. If South leads the ♠5, West can safely take it with his ♠K and return a spade because he knows South will be forced to overtake dummy's ♠7 with one of his remaining spades (he has no small spades). On top of that, South then loses two hearts for down two (or possibly a heart and club) for down two. I suggest that there is no way to make contract.

Comments on this problem have also come from Earl V. Beven, David E. Borenstein, Robert C. Camp, James Flemming, John Kreuttner, Solomon L. Pollack, Glenn Stoops, and Herve Thiriez.

52 This is the one about the action of a helium-filled balloon tied to the floor of a decelerating railroad car. In the March/April issue I wrote, "Everyone says the balloon moves forward, but I disagree. I feel that the air in the car will go forward creating a high-pressure area forcing the balloon backwards." All subsequent correspondence supports my contention (which was not precise), and R. Robinson Rowe has now added the needed precision:

For a working model, I presume a railroad car with rigid boundaries enclosing a prism of air 50 ft. long at standard conditions. The width and height are not relevant, as the analysis can be confined to a subprism of unit cross section $1 \times 1 \times 50$ ft., made up of 50 unit cubes of air. Each cube of air weights 0.08072 lb., which I will round to 0.08 lb., so that the subprism weighs 4 lb. We must deal with absolute pressures, which are 2120 lb./ft.^{2}. The subprisms are surrounded with like subprisms, which balance the forces acting on the long faces; but each end of the subprism is in contact with the end-wall of the car, where the reaction is 2120 lb. Now presume a deceleration at the constant rate of 0.5 g. (that is, about 16 ft./sec.^{2}). When equilibrium is reached, the decelerating force will be 0.5×4 lb. $= 2$ lb. This will be the difference between the reaction at the forward end of the car and the reaction at the rear end of the car, these becoming 2121 and 2119, respectively. For these reactions to exist, air densities must change, and it can be shown that density will vary linearly from one end to the other. Presuming also that change in air density

is adiabatic and isoentropic, PV must be constant. The volume of a cube at the rear of the car expands to 2120/2119 ft.^{3}, which is also the measure of its new length, and at the head end it becomes 2120/2121 ft.^{3}. If x is the distance from the rear end, the change in length of cubes can be expressed as $1.000472 - 0.00001888\ x$. Its integral is $1.000472\ x - 0.00000944\ x^2$. Then the change in distance from rear end to any cube is $0.000472\ x - 0.00000944\ x^2$, for which the maximum, at $x = 25$, is 0.0059 ft., or about 1/14 in. At this equilibrium, the linear variation of pressure means less pressure on the rear of the balloon than on its front, and the string leans backward. But at first, when the air is moving forward, it will impel the balloon with it. Like a string under a suddenly applied load, the air will overreact, to perhaps double the 1/14 in., and oscillate with a damped vibration approaching the equilibrium condition, with the balloon responding in phase. A small but definite "wobble."

I must also include the engineering approach, from Edward J. Sheldon: I was shocked, appalled, and aghast (not to mention amused) when I read your solutions to the balloon in the decelerating railway car. I immediately concluded that the problem could be solved experimentally. Today my daughter came home from the April 19 parade (held of course on April 17) with a lighter-than-air balloon perched on top of a string; this was half of the experimental equipment needed. Unfortunately, I did not have a railway car available so substituted my trusty Toyota. Enlisting the aid of my son to hold the balloon, I proceeded with the experiment. The car was driven at a rate of about 20 m.p.h., the balloon stabilized, and then the brakes were applied. The balloon went to the rear! This experiment was repeated at least three times with similar results; further, when the car was accelerated the balloon went forward. Why were you wrong? Because you only *felt* ("I feel . . .") the correct answer. As you are a mathematician, the thought of actually performing a scientific experiment may well have been repugnant. However, as an engineer, I had no such qualms; and it can now be stated as fact that the balloon moves backward.

Other responses have come from Gerald Blum, Ralph Brown, T. Stewart Harris, Joseph Horton, Rowland Johnson, R. A. Pease, Barry Skeist, and Michael D. Zuteck.

54 Walter I. Nissen, Jr.

55 R. Robinson Rowe kindly sent me a copy of his solution, the original having been lost due to a mix-up in numbering. Indeed, he submits two solutions which together are far too long for the space available for this or any other installment of "Puzzle Corner." But here is his introductory comment: "This problem would have been skipped as likely to yield at best a dual formulation, separately for odd and even arguments. I had played around with similar problems and had had to resort to 'oddtorials'—like factorials, but continued products of odd numbers. I was even confused by ambiguity of some of the questions. But it had one redeeming feature—it reminded me of my own sock-sorting sorties, I being an elderly widower served by a once-a-week housekeeper who leaves my socks hanging on the line with the rest of the laundry. So I went to work. When a function didn't formulate, I computed the hard way up to $N = 7$—a reasonable limit for once-a-week laundry."

Anachronisms: DuPont, Delaware, and Ralph Nader

Book Review:
Brooke Hindle, Killian Visiting Professor, M.I.T., 1971-72

Pierre S. du Pont and the Making of the Modern Corporation
Alfred D. Chandler, Jr., and Stephen Salsbury
Harper and Row, New York, N.Y., 1971, $17.50

The Company State: The Nader Study Group Report on Du Pont in Delaware
Center for Responsive Law, Washington, D.C., 1971, 2 vols., $25.00

These two volumes demonstrate two very different responses to a single corporate subject—Du Pont and the du Ponts; in methods and standards, they have little in common. The first represents a milestone in historiography; it is one of the best business biographies yet written. The second reports the Du Pont excursion of the "Nader raiders." The relative usefulness of the two approaches depends in part on the perspective of the reader; but the impact of the second as a social document must surely be compromised by its shortcomings as history.

A Corporate, Not Personal, History

Chandler and Salsbury have reached literally inside the mind of Pierre du Pont to interpret his role in transforming both Du Pont and General Motors into their modern corporate form. This study is based upon voluminous records, notably upon the recently organized personal and business writings of Pierre du Pont and upon personal interviews conducted by Chandler. (Some readers of *Technology Review* will recall that Chandler was on the M.I.T. faculty from 1950 to 1963.)

This is an account of a man who went into the powder yard of his family firm as soon as he graduated from M.I.T. in 1890, left to demonstrate a peculiar organizing ability in steel and street car companies, and returned in 1902, soon emerging as the major architect of Du Pont development. He established organizational patterns in the company and arranged acquisitions and agreements in the industry which permitted Du Pont to respond to a series of challenges and to emerge from each with a larger and stronger role.

Pierre's acceptance of the presidency of General Motors in 1920 carried him into a business with which he had only limited and recent connections. The automobile industry was in its infancy and was altogether a different sort of enterprise from Du Pont; Pierre undertook leadership as a business manager. He not only reorganized the sprawling empire efficiently but also worked effectively in developing sound product policy, market strategy, and technological experimentation and innovation. Here, as at Du Pont, he demonstrated genius in backing the best men, especially John J. Raskob, who had also served in Du Pont, Alfred P. Sloan, Jr., and Charles F. Kettering.

A major achievement of the authors lies in maintaining an interesting, and often exciting, narrative despite the tortuous tangle of financial negotiation and arrangement which, in less adept hands, would become the dullest form of history. Something of the outlook and character of Pierre, the man, emerges, too, although a conscious decision was taken not to probe his personality or to write a full-scale personal biography. This is, perhaps, the greatest weakness of the book; more understanding of the man himself does seem needed. Without discoursing upon his attitudes toward social responsibility and ethics, the authors sharply note Pierre du Pont's sense of bafflement with government and external criticism which seemed to challenge his own integrity and rectitude.

The Impact of Economic Concentration

It is precisely the social effects of the actions of Pierre's successors that concern the Nader Study Group, but their project examines a different world through markedly different lenses. *The Company State* is a combination of a lawyer's or debater's brief with a journalistic exposé. It shows little interest in history, ethical motivation, or understanding for its own sake. The objective is action, and the basis is an investigation undertaken to discover what faults could be found in the relationships between the Du Pont Company and family and the communities within Delaware.

Du Pont, of course, makes a wonderful target. Much has been uncovered that is blatantly wrong, undesirable, or short of the ideal. Fundamental aspects of the Delaware pattern are offensive to the American sense of democracy and equality. So great a concentration of economic power within a single company and family must have a pervasive impact upon every aspect of politics and life in a state as small as Delaware and a metropolis as modest as Wilmington.

Despite the earnestness and general ring of truth characterizing the *Report*, the lack of the objectivity Chandler and Salsbury enforce upon themselves is conspicuous. All of the minuses discovered are included in the summation, while some of the pluses are discounted. For example, one would assume that an unusually high rate of retention of employees would be praiseworthy—here it becomes evidence of paternalistic restrictions upon freedom; one would assume that Du Pont's support of the University of Delaware would be beneficial—here it is contrasted with the failure to support equally the predominantly black Delaware State; one would assume that

a fine industrial safety record could only be good—here it represents a mechanism for weakening unions. The credibility of the *Report* would be strengthened by greater balance and objectivity, although this might, at the same time, weaken its exhortatory effect.

Recommendations of the Nader group likely to commend themselves most easily include efforts to strengthen the sometimes supine organs of government in Delaware and to reduce the special privileges acquired by the Du Pont family. The most indefensible privileges, of course, are a general American problem; still, the documentation here of enormous personal incomes going almost entirely untaxed calls urgently for action. On the other hand, only a limited response to the demand for community representation on Du Pont Co. and foundation boards would seem wise. Some of these recommendations seem to look toward establishing a populist sort of social justice as the corporate objective.

The Delaware which the Nader group discovered is truly an anachronism; it is too much an extension of the world of Pierre du Pont. Yet, to correct constructively the abuses characteristic of that world requires a better understanding of Pierre's achievements and values than this *Report* reflects. Surely the need is to attain greater social justice—without destroying the wealth-producing capacity of such a company as Du Pont and at the same time without destroying the humane and peaceful atmosphere of the Delaware countryside.

Further Comments: Limits to Growth

Book Review
Myle J. Holley, Jr.,
Professor of Civil Engineering, M.I.T.; and
William W. Seifert,
Professor of Engineering, M.I.T.

The Limits to Growth: A Report for the Club of Rome's Project on the Predicament of Man
Dennis L. Meadows, Donella Meadows, Jorgen Randers and William Behrens
Universe Books, New York, 1972, 208 pp., $2.75 paper; $6.50 cloth

The Limits to Growth represents another and an important step in a continuing effort to gain a fuller understanding of complex socioeconomic systems through dynamic modelling.

From the time of Malthus scattered voices have warned that the population of the earth could grow to exceed the capacity of the earth to support it (particularly with respect to food). *The Limits to Growth* goes further and indicates that the finite limits on mineral, as well as food, resources coupled with the capacity of the globe to dissipate pollution implies a limit not only to a continuation of growth in population but also of continued economic growth. Because the growth ethic has been such an important underlying philosophy in those countries now classed as "developed," it is understandable that *The Limits to Growth* has become the focus of even greater controversy (*see, for example,* The New York Times Book Review *for April 2, 1972*) than the earlier efforts in modelling urban systems (*see* Technology Review *for April, 1969, pp. 21-31*) or the world dynamics effort from which this most recent work grew.

The authors of *The Limits to Growth* candidly admit the preliminary state of their work (p. 22) and are pleading to others "to raise the space and time horizons of their concerns" and realistically begin to assess the longer-range alternatives facing mankind. Although no such assessment, on the scale and level of organization needed, has yet been initiated, small but increasing numbers of scientists and engineers are beginning to question whether current growth rates can be sustained much longer. It must be acknowledged that such scientists and engineers are, as yet, a small minority. However, among economists the number of questioners is, by comparison, miniscule, a regrettable fact since serious assessment will require collaborative effort by professionals from many disciplines—particularly, economists.

The work by Meadows and his colleagues has, indirectly, brought into sharp focus an underlying faith which sustains those who see no near-future cause for concern regarding continued exponential growth. It is a sincere conviction that technological progress will proceed at a corresponding exponential pace, enabling society to resolve all of the growth-related difficulties (e.g., resource depletion, pollution) as they arise. Scientists and engineers have an urgent obligation to examine the validity of this assumption.

A great strength of the Meadows' work was that the group was able to formulate an explicit and plausible model to permit examination of ways in which population, resources, pollution and capital investment *may* interact in the total system. Whether or not the specific interactions postulated in the model represent the true situation, the fact remains that these sectors do interact, and the total system cannot be understood by examining each component in isolation. Nonetheless, in order to focus the discussion, let us consider one issue at a time.

Limits to Population, Resources, and Pollution

With regard to population, the Meadows team is merely adding its voice to the many others who are saying it is time to critically weigh the advantages and disadvantages of continued rapid population growth. Because world population would continue to grow for 60 or 70 years even if all countries immediately achieved a replacement birth rate, the problem of population growth is urgent. This inherent momentum, and the strong interaction of population with other aspects of growth, should intensify our concern with population growth. It is naive to assume that this aspect of the growth problem will yield to "new technology" alone.

The problem of resource depletion sometimes is countered by the statement, "Specialists usually agree that cheap energy is the critical long-term constraint on output of raw materials." It is true that the availability of cheap energy has enabled us to economically exploit much lower-grade ores than hitherto possible. Two immediate problems become evident as one visualizes pushing this approach further and further. First, one can question whether, over the next few decades, it will be possible, even if it is assumed that present technology will be adequate, to bring into operation energy supplies sufficient to permit recovery of ever lower-grade ores. The second problem associated with recovering minerals from low-grade ores relates to the disposal of the residue after the desired minerals have been extracted. Even though current mining operations focus on relatively high-grade ore, runoff from the tailings of coal and other mining operations is already a serious source of pollution of streams, while the scarring of the landscape by strip and open-pit mining leads to serious degradation of the natural environment. How much worse the situation will be if we are forced to exploit much lower grade ores and thus handle much larger quantities of tailings for each ton of metal extracted!

Technology exists which would permit us to very significantly reduce much of our pollution. This technology is already being applied, and indications are that increasing attention will be directed to this problem. Nonetheless, the mere "keeping up" is much more difficult in a rapidly growing society. Furthermore, pollution control ultimately imposes additional costs and, usually, requirements for additional energy.

Can Technology Grow Exponentially?

There are, in fact, very real technological reasons to question whether recent energy growth rates can be indefinitely sustained. Anyone who is familiar with the lengthy time and the enormous industrial effort required to produce a single modern power plant must question whether a ten-fold increase in the rate of producing such plants can be achieved in but a few decades. Indeed, exponential growth rates for energy cannot long persist at levels in excess of other measures of economic and industrial growth, a simple fact which cannot in any way be altered by "new technology." When one considers, in addition, the implications of a ten-fold increase in the problems of local thermal pollution, or a hundred-fold increase in the task of transporting and handling nuclear wastes, both of which are implied by projections of current energy growth rates over the next 30 years, he cannot but question whether those growth rates will be maintained. These are difficulties that cannot be eliminated by the "exponential growth in technological progress" on which many rely.

In the longer run it is indeed likely that technological progress will eliminate fuel resource depletion as a possible constraint to energy production. At present exponential growth rates, however, questions of heat dissipation would become globally significant within a surprisingly few human generations. There are immutable physical laws which render in-

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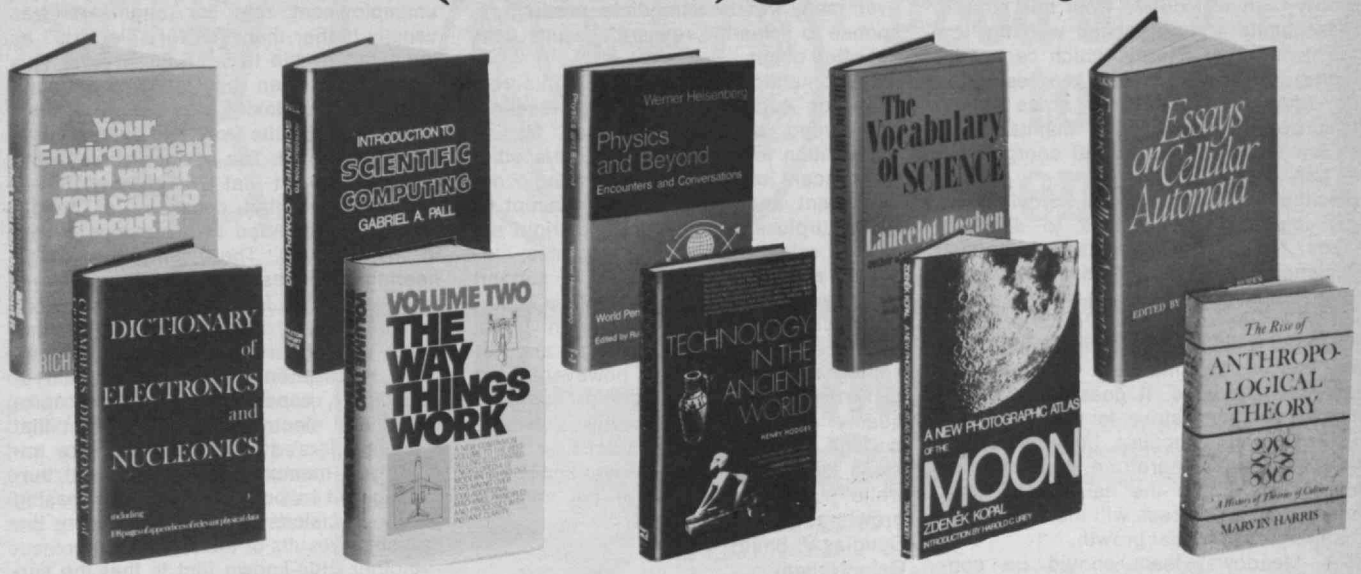

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escapable this limitation on man's conversion of matter to energy. Conversion of the solar energy which impinges directly upon the earth's surface appears to offer the only technological means to bypass this energy limit, but there are very real practical limits to the amount of energy man will derive from this source. These limits are associated with the low density of solar energy, which cannot be altered by technological progress, and the enormous collecting areas which must be constructed and maintained if we are to derive substantial energy from the sun.

Technology can, and will, provide further impressive responses to society's needs for energy. Greater conversion efficiencies, more effective ways of handling local problems of thermal pollution and eliminating other forms of pollution, and removal of the possible limitation implied by finite fuel resources, all can be anticipated. It goes without saying that we must strive for the utmost in such progress, because benefits to society will derive therefrom; but we must not be lulled into the naive belief that technological progress will make possible unending exponential growth.

The Meadows team should be congratulated for forcefully pointing out potential dangers of unbridled growth and urging serious debate on these important issues. Physical scientists and engineers must recognize not only their important role in this emerging debate, but the extent to which their responsible assessment of physical limits will be an essential prerequisite to the involvement of other professionals.

Letters

Continued from page 5

Research and the Quality of Life

The desire of Victor Cohn that funds for scientific research be increased is understandable and—if the increases were to come in areas of social merit—admirable (*see "Lip-Serving Research While Cutting Muscle," October/November, pp. 8-9*). There appears to be some confusion, however, as to why such research is important. A casual look around is enough to convince many of us that the technologic fruits of such research are not useful per se and are positively harmful when applied to purposes of war, supersonic transport, inner-city highway construction, and other "growth-producing" nightmares.

Mr. Cohn has apparently decided that if he cannot justify such research by appealing to the pure "need" for more economic growth, he can support science by bringing up that old bogey—trade imbalance. At first glance there appears to be no reason whatsoever why the U.S. should care whether or not its trade balance was in deficit or surplus. The U.S. has had balance of payments deficits (not trade deficits) for years, and the apocalypse has refused to arrive.

Even if trade imbalance were somehow bad it is hardly obvious that scientific research will make much difference. The trade deficit Mr. Cohn worries so much about has its roots in decisions made over many years. Immediate product response to scientific research results does not often occur.

My contention is that Mr. Cohn's reasons for supporting scientific research are wrong because increased foreign competition is due to many factors other than recent cutbacks in technologic development and because the concept of trade surpluses only exists with rigid exchange rates; and, given such rates, surpluses are used by the U.S. to support aggressive activities. Nevertheless I support scientific research! Foreign trade, "defense," or national prestige are not among my justifications, however. I am convinced that some of our problems of quality of life can be partly alleviated through technological solutions. It is to these quality issues that we must turn while purging ourselves of the myth of growth-as-savior.

Douglas V. Smith
Oslo, Norway

Employment: The Statistics

I was particularly interested to read the article by Raymond J. Waldmann in *Technology Review* for December (*"Redirection and Re-employment," pp. 27-31*) because I directed the Engineers Joint Council/National Science Foundation survey of engineering employment that provided much of the data used in the article and its illustrations. Some of my comments are based on detailed statistics that may not have been available when the article was written. Others are simply observations that I think will be of interest to other readers.

The article unintentionally gives the impression that the ten areas shown in the first bar graph are those with the highest rates of engineering unemployment. The statistics in question were first released in the N.S.F. report of September 23, 1971, as relating to "the fourteen areas designated by the U.S. Department of Labor as being severely affected by unemployment of scientists, engineers, and technicians." Since these areas were so designated *before* the E.J.C./N.S.F. survey was conducted, it was not known whether the same areas would show the highest *engineering* unemployment rates. As a matter of fact, the detailed survey data revealed that there were many areas where engineering unemployment was higher. For example, the following *entire states* have higher rates than some of the areas listed by N.S.F.: Arizona, 4.4 per cent; Rhode Island, 3.8 per cent; New Mexico, 3.6 per cent; Oregon, 3.1 per cent. The point is that engineering unemployment and overall unemployment are not necessarily concentrated in the same areas. Unfortunately the Labor Department's Technology Mobilization and Reemployment Program is limited to people who lost jobs in aerospace or defense work in the 14 target areas previously mentioned. The fact that engineering unemployment was prevalent in other industries was emphasized by engineering representatives at the March 3 meeting at the White House mentioned by Mr. Waldmann but has apparently not yet been translated into action at the departmental level.

Mr. Waldmann makes a point that "the unemployment rate for engineers was usually higher than that for scientists" as indicated by the two N.S.F. surveys. This is true only when the statistics are compared without taking into account basic differences in the way the two surveys were conducted. The science survey went to a mailing list that was already over a year old and that consisted of people who had responded to a previous survey in March 1970. The twenty-three engineering societies whose members were surveyed by E.J.C. made strong objection to the use of a previous survey list. E.J.C. put together a list of 498,000 members, representing a broad spectrum of disciplines, especially the critical aerospace and electrical fields. The fact that the engineers' survey reached more unemployed members is therefore not surprising, but I would advise against basing policy decisions on differences in the statistical results of the two surveys.

Another little-known fact is that the survey statistics for the under-25 age group are inherently of questionable reliability. Young engineers are not well represented in engineering society memberships because people generally do not join until they are more experienced. Too, the survey was not intended to cover student members of the societies. There were only 71 unemployed respondents in the 24 and under age group and 193 between 25 and 29. Moreover, of the 1,668 unemployed engineers identified by the survey, 91 listed themselves as full-time and 99 as part-time students. It is logical to assume that most of these students were in the younger age groups, and that many of the ostensibly unemployed were really not available for normal engineering jobs. The National Science Foundation, because of fund limitations, did not provide the cross-tabulations that would positively resolve this point, but again I would hesitate to use these survey statistics uncritically to support a conclusion that "the young graduates who were unable to find jobs and who were most susceptible to easy discouragement and frustration were the most vulnerable." In my judgment, speaking only of engineers, it is the older ones who are most vulnerable to unemployment and have the most cause for discouragement and frustration.

My final comment is that a one-time snapshot does not really provide a good picture of the complex and changing employment situation among engineers and scientists. For example, independent and more recent studies show that employment in chemical engineering, which was good last spring when the N.S.F. survey was conducted, has worsened considerably in the last few months. What is obviously needed is a program to keep continuous surveillance of the changing picture in engineering and scientific employment through periodic surveys of *demand* as well as supply, to devise corrective actions aimed at easing specific

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manpower mismatches, and to adjust these actions as new data and informed judgment may dictate. Engineers and scientists are an irreplaceable national manpower resource. Efforts to improve their utilizition are therefore in the national interest as well as the interest of the professions.

John D. Alden
Executive Secretary, Engineering Manpower Commission, Engineers' Joint Council, New York, N.Y.

Employment: Myths and Misconceptions

I found Raymond J. Waldmann's article on the unemployment problem quite disturbing. What bothered me is that Mr. Waldmann continues to propagate some of the common misconceptions about the problem.

One source of the problem is that we have for many years put all our high-technology research in a limited number of areas. Thus, when one industry is hit (aerospace/defense), all significant research and development in the physical sciences is hit. I'd be glad to be "retrained" if you can find me any industry that uses high technology and is not hurt by the current "re-ordering of priorities."

Another source of the problem is our failure to make clear to the public how research and development supports the entire U.S. economy. The technologists have never bothered to explain their side to the public, and the politicians (if they even understand it) have no incentive to make the explanation.

Two types of technical people are caught in the current unemployment problem. One was attracted to technology purely by high pay and had no ties of concern to the work at hand. The real problem today is the professional who entered his field from interest, who worked many hours of unpaid overtime, who was career oriented, and who is likely to have no patience with unions and make-work. The myth is that this type never gets laid off.

H. L. Elman
Glastonbury, Conn.

Mr. Waldmann responds:

Although my article dealt exclusively with government efforts to retrain and reemploy engineers and scientists, Mr. Elman raises two other issues of technology policy.

The first question is whether we need to put all our high-technology eggs in one basket. It is not that we are unaware of this problem; as the first paragraph in my article states, the President had asked for a major study of this question, the results of which have already been announced.

The second problem Mr. Elman raises is our failure to make clear how research and development supports the economy. I agree with Mr. Elman that this is a significant problem and I hope both the government and the professional socieities and universities can make significant contributions to overcoming it.

Far from supporting only the idea of retraining, as Mr. Elman suggests, the article clearly, in the last paragraph, states, "(The President) does not believe the problem of utilizing scientists and engineers should be 'solved' with temporary jobs or highly visible retraining opportunities." We are very much concerned that this point be understood. My article described only one aspect of the more general policy issue. It should not be read as the only response this Administration is making.

Japanese Computer Opportunities

Your summary of Professor Franklin F. Kuo's report on the Japanese computer industry (*"Trend of Affairs," January, pp.* 65-66) conveys two erroneous impressions: first, that the Japanese computer industry is self-sufficient; and second, that Japan is not a profitable export market for the American computer industry.

The government of Japan has historically protected and actively supported industries which are important to the future of the nation and which are not self-sufficient. The computer industry in Japan has been and still is the subject of such protection and support. Several examples of government support are given in your article. The Japan Electronic Computer Co., for example, was started under the guidance of The Ministry of International Trade and Industry (M.I.T.I.) to aid domestic manufacturers in lease financing so that they could be competitive with I.B.M., with funding in large part provided by the Bank of Japan. M.I.T.I. has also encouraged and recently accomplished a merger of the computer interests of Hitachi and Fujitsu, Nippon Electric and Toshiba, and Oki and Mitsubishi with the objective of making a new "big three" which would be more competitive internationally and domestically than the old "big six." Thus the Japanese government by its actions continues to testify to the lack of self-sufficiency of the computer industry. Further, the prices, performance, and technology of the purely domestic computers (i.e., those not built under license) in Japan confirm the lack of competitiveness of the industry. Finally, only about 50 per cent of the computers in Japan are purely domestic.

For many reasons Japan today provides an excellent and profitable export market for the American computer industry and it will continue to do so in the future. The most fundamental reason is the current weakness (or lack of self-sufficiency) of Japan's computer industry. While you cannot simply sign a sales agreement with a trading company and sell all of the computers you want in Japan (as the publicized experience of Digital Equipment Corp. attests), there are many ways of doing business in Japan profitably. The Japanese have respect for excellence in technology. The "not-invented-here" syndrome is almost nonexistent in Japan; thus the Japanese are willing to buy products, enter joint ventures, enter sales agreements, and/or license in order to speed the development of their skills.

Another basic reason is that Japanese wages have grown even faster than the country's Gross National Product in the last decade. High wages (fifth in the world), low unemployment (1 per cent), a highly educated work force (over 99 per cent literacy), a need for higher productivity—all these provide an important base for exceptionally rapid continued growth in the computer market in Japan.

Finally, the Japanese computer industry is scheduled to be "liberalized" in 1974 so that all forms of trade with the United States will be freer and government restrictions will be fewer. Now is the time to act.

The obvious advantages to an American company of doing business in Japan are the additional sales and the disclosure fees and royalties for know-how or patents. Small, growing, high-technology companies particularly can find doing business in Japan rewarding. The profit thus obtained can be thought of as an additional capitalization on the products and technical capabilities which the company has developed.

But equally important longer term benefits can also accrue from having a partner in Japan: production may be more economically divided between the United States and Japan to assure the lowest-cost product in both countries; the Japanese partner may offer new products for manufacture or sale in the U.S.; and the Japanese partner may become a source of capital for the U.S. partner.

The second point is particularly important. Most smaller, high-technology companies think of their assets primarily in terms of the technology they have mastered and the products they have developed. However, particularly to a Japanese partner, the *organization* they have built and the *marketing skills* they have developed are of equal importance and value. The Japanese recognize the difficulties of establishing a reputation and marketing and servicing technical products here. Therefore, they look to an American partner for help in doing business here.

Norman Doelling
Doelling Associates International
Lexington, Mass. 02173

Innovation in Science Education

The teaching technique discussed by Stewart Wilson in "Interactive Lectures" (*see* Technology Review *for January, pp. 50-57)* has distinct advantages over videotape and conventional coordinated tape and slide presentations. This is particularly true, I think, for the sciences.

There are, at first glance, several areas in undergraduate education that would be amenable to this approach in instruction. One is remedial work in and/or reviews of material that is presupposed in course work at all levels. This might include logarithms in general chemistry, Euler's relation in physical chemistry, etc. Second would be development of concepts that appear to cause particular difficulty to students, for example, the mole concept in general chemistry.

A third application would be the possibility of offering specialized course work in areas that would be normally restricted because of lack of staff time or the inability to justify course load to an administration because of the small number of students involved.

Norval C. Kneten
Fort Worth, Texas

Self-taught, Peer-taught
I have read Dr. Stewart Wilson's "Interactive Lectures" *(January, 1972, p. 50)* with considerable interest. The most significant aspect of the work seems to me to be the way he is incorporating into the system the contribution of the student to learning—both his own learning and that of his peers. Having learned—and, I hope, continuing to learn—much from my own students, this seems to me a valuable step forward.
A. Horder
London, England

Holds Great Promise
I was pleased to read in *Technology Review* about the work of Stewart Wilson on "Interactive Lectures." My greatest pleasure derived from sensing Mr. Wilson's humanistic approach to the research problem, e.g., ". . . technology's deepest contribution to education should occur . . . in the creation of individually responsive systems." I believe that technological research based upon principles like this holds great promise for mankind. It also ameliorates current fears that technological solutions to societal problems are impersonal and thereby counterproductive.
Hugh C. Russell
Washington, D.C.

Politics and the President
Without attempting to argue the antibombing position which it takes, I would like to pose some thoughts about the type of statement represented by that of the Ivy League university presidents and Jerome B. Wiesner (*see* Technology Review *for June, p. 75*).

Although the statement was presented as the individual view of each of the presidents involved, this is plainly ridiculous. Mr. Wiesner was clearly acting as the university executive, and this was the sense delivered in the capsuled network reports, as anyone could have predicted. When he uses his office as a political sounding board, he appears to represent the entire M.I.T. community and places the onus of his opinions on many students, faculty and alumni who disagree with him. In short, his jurisdiction as a university president is severely limited here. He was elected to administer the university, not to broadcast spurious foreign policy opinions.

I believe that he and the others formed an alliance to limit the expected student demonstrations, even to the extent of a wholesale prostitution of their positions as university presidents. Apparently, the cowardly college officials of the 1960s remain undaunted. The sad fact is they will never realize that unreasonable concessions breed unreasonable demands.

I have followed the trend of the "socialization" of scientists closely for the past few years and have tried to point out the fallibility of the logic espoused by its advocates. Scientists must remain aloof from the political aspects of their work in order to give objective and factual appraisals and allow themselves to be guided by the wishes of the democratic majority. The breakdown of this system might allow a handful of qualified scientists to veto a scientific project desired by the vast majority of the people and their elected representatives either by a biased presentation of the facts in order to distort opinion or by an outright strike. In the reverse, unlawful projects might be attempted by a committed few. An indication of this trend was vividly seen in the Congressional hearings on the S.S.T. and the A.B.M. Experts in the so-called precise sciences who had entered their studies with extreme preconceived biases ended up giving testimony on the scientific possibilities of these systems exactly opposite to each other. The net result was that most Congressmen admittedly ignored the testimony in favor of gut feelings.

In an institutional sense, these same principles apply. For years, the American people and their representative government looked to M.I.T. and its associated laboratories to perform much of the scientific development and research which they desired. Now the trend is to tell the American people in the form of nonscientific value judgments that they are wrong and that M.I.T. will decide what work is to be done. A good example of this was the hysteria concerning defense work performed at the Instrumentation Laboratory and the resulting changes which took place against the wishes of the personnel involved. This is an elitist attitude and amounts to government by the minority, especially if the few other qualified laboratories follow M.I.T.'s lead in blacklisting certain projects. M.I.T.'s role is to make scientific recommendations in cold objectivity and leave value judgments to the ballot box.

Thus Dr. Wiesner does a great disservice to the scientific profession and to M.I.T. when he takes these public political stands. Also, I would exhort him to do his job instead of buckling under every student pressure group that comes along. His responses to these situations are so predictable as to be laughable.
Michael J. McNutt, '69
Urbana, Illinois

Politics: the Institution and the President
I would like to comment on Dr. Wiesner's pronouncement on the Vietnam war, issued jointly with presidents of other educational institutions (*see* Technology Review *for June, p. 75).* When I heard it reported on the evening radio news last April, it was presented as a statement by the presidents of the institutions concerned but without mention of the first clause of the statement which says that a personal rather than an institutional value judgment was being rendered.

In my opinion, this presentation has produced two undesirable effects: First, placing the prestige of the institutions behind the value judgments of a small number of individuals; and second, making political pawns out of members of those institutions.

Since these effects were apparently not Dr. Wiesner's intention, I request that he take appropriate measures to insure that the personal nature of this pronouncement and of future pronouncements be made abundantly clear in implementation as well as conception.

The comments I make in this letter are my own personal opinion and do not represent the official opinions of my department or any institution with which I may be affiliated.
Michael S. Drooker, '64
Department of Ocean Engineering, M.I.T.

Dr. Wiesner replies:
I will try to insure that the news media adequately reflect the personal nature of my statements. This is hard to do and as a consequence I have greatly reduced my public pronouncements since becoming President of M.I.T. But, I hope that on such few occasions as conscience and self-respect compel me to speak out, I will make sure that you and other M.I.T. associates are not identified with my views.

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Institute Review

Controlling Costs and Rising Need: A Report on M.I.T. Budgets and Research

When all the accounts are finally figured, M.I.T. will finish the 1971-72 fiscal year with about $4 million of operating costs in excess of operating income, Paul E. Gray, '54, Chancellor, told the M.I.T. faculty at its last meeting this spring. That amount will have to be made up from unrestricted funds, he said.

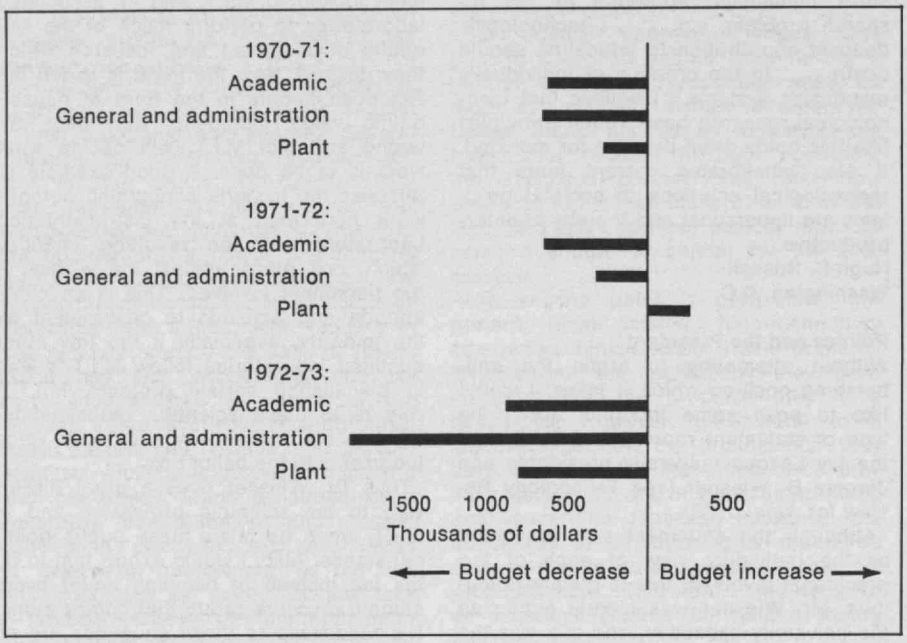
This demand of $4 million on unrestricted funds compares with a similar figure of $5.4 million in 1970-71. Current planning suggests a demand of only $2.9 million for unrestricted funds in operations during 1972-73.

Because receipts of unrestricted funds "are subject to large fluctuations and are difficult to predict with accuracy," Dr. Gray could say only that such funds would range between $3.5 and $4 million this year and next. Thus, he told the faculty, "if unrestricted revenues and gifts are used primarily for operational purposes" there will be only "a small excess need in 1971-72 and no such unfavorable imbalance in 1972-73."

Meanwhile, Walter A. Rosenblith, Provost, told the M.I.T. faculty at the same meeting that research funds coming to the Institute have increased significantly during the past year, and a further increase is expected in fiscal 1972-73. The figures, he said, are $56 million in 1968-69, $58 million in 1969-70, $61.7 million in 1970-71, and $70 million in 1971-72. The forecast for 1972-73 is $75.3 million.

No Deficit—But Little Comfort

To achieve a budget calling for only $2.9 million of unrestricted funds in 1972-73, Dr. Gray said, the Institute will next year reduce its academic and administrative budgets by some $3.4 million. The largest cuts are being made in general and administrative expenses (10 per cent) and plant maintenance (6 per cent); in the academic programs cuts for next year average only about 4 per cent. These savings are offset in part by necessary increases in salaries and wages, and by $400,000 which has been reserved in the new budget for innovative educational programs. Increased income from tuition and from overhead on the larger volume of research is required to reduce to $2.9 million the need for unrestricted income.



For budgetary purposes, M.I.T.'s operating expenses are divided into three categories—academic, general and administrative, and plant. Budget reductions in the past two years have impacted most sharply on academic and general and administrative expenses. In all, budget reductions scheduled for 1972-73 are larger by a factor of two than the reductions achieved in either of the two previous fiscal years. The total budgets for 1971-72 in the three categories are academic, $31.5 million; general and administration, $21 million; and plant, $13.3 million.

But Dr. Gray found little comfort in his report. "The fact that unrestricted revenues and gift income will suffice to cover the operating deficit (in 1972-73) is not, in itself, cause for rejoicing," he said. "Such funds, which are the most difficult to raise, have in the past been used to complete the funding of capital projects, to renovate dormitories, to start new academic enterprises, to increase endowment funds, and for other non-operational purposes.

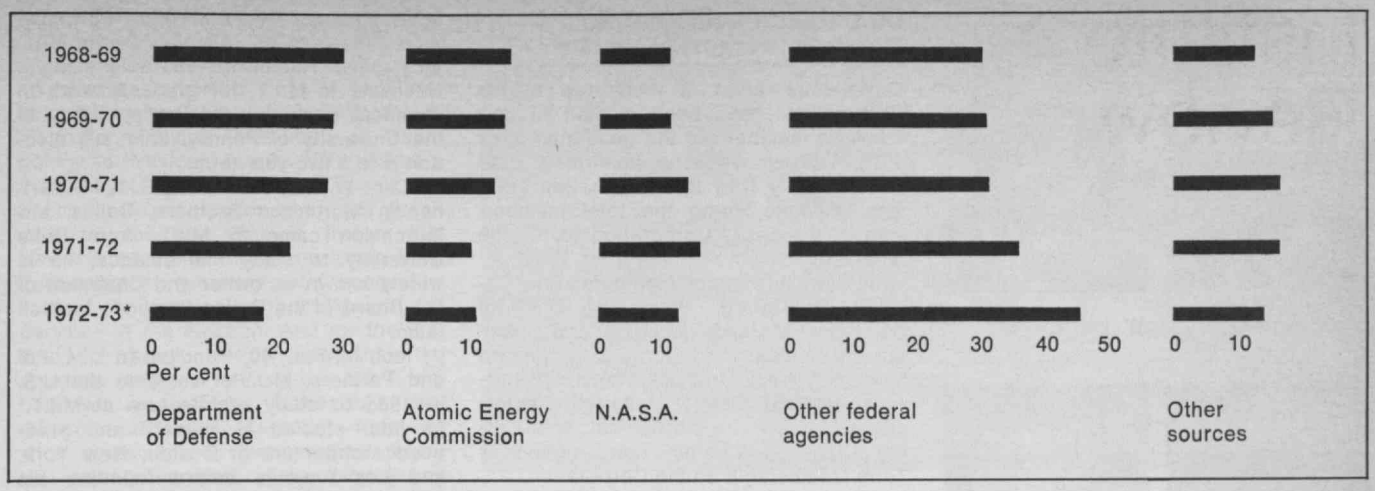
"It seems to me essential for us to bring the operating budget more nearly into balance so that unrestricted resources need not be committed overwhelmingly to operational needs, as they are during the current year," he said.

And he also noted that, though the new administration's intensive efforts to control M.I.T.'s financial operations have borne significant fruit, the end is not in sight. "The hard fact is that salary and wage increases (even at the modest level of 4 to 5 per cent per year), other inflationary cost increases, and small allocations for new programs will continue to put an upward pressure on the operating budget of about $2.5 million per year.

"Annual tuition increases, even at the modest level of 4 to 5 per cent per year, and foreseeable growth in endowment income and in research contract allowances develop only about $1.4 million a year. The difference, amounting to more than $1 million per year, must be made up either by continued annual budget reduction efforts or by developing new sources and forms of income."

Sources of Research Funds

A highlight of Professor Rosenblith's report on research funds was the marked change in the sources of M.I.T.'s research sponsorship during the past five



The sources of federal research funds at M.I.T. have changed dramatically in the past five years, the Department of Defense dropping from 30 to 17 per cent (estimated for 1972-73) and other federal agencies—notably the National Science Foundation and the Department of Health, Education and Welfare—rising from 30 to 46 per cent. The contribution of non-federal sources to M.I.T.'s research volume remains roughly constant. The asterisk indicates estimates.

years. In fiscal 1968-69, the Department of Defense was responsible for 30 per cent of the Institute's sponsored research; by 1972-73 that figure will be down to 17 per cent. The largest increase in research sponsorship has come from the Department of Health, Education and Welfare—from 11.5 per cent in 1965-66 to 19.1 per cent in 1972-73.

More than half of the Institute's sponsored research in 1972-73 will be performed in the interdepartmental laboratories, including electronics, nuclear science, space research, international studies, bioengineering, and others. Of the balance, $18 million is forecast to come to the School of Science, $15 million to the School of Engineering, $1.8 million to the School of Humanities and Social Science, and $1.2 million to the School of Architecture and Planning, Professor Rosenblith said.

While research support is expected to increase in 1972-73, federal support for graduate students will continue to decrease. The peak came in 1968-69, when some 600 M.I.T. students in the Graduate School benefitted from federal grants; a year later the number was down to 533, in 1971-72 it has been 436, and for 1972-73 the estimate is roughly 300, according to Professor Rosenblith. This forecast is made, he said, "despite the fact that more first-year National Science Foundation Fellowship holders have chosen M.I.T.—more than 14 per cent—than any other institution in the country; and in spite of the fact that one department—the Department of Economics—has attracted 50 per cent of all first-year N.S.F. Fellowship students in its field."

An Educational Institution Votes as a Shareholder

How shall an institution concerned with the public good but dependent on income from its corporate investments use its power as a stockholder on controversial corporate issues?

To help answer that question in the case of M.I.T., the Institute's Corporation has named an Advisory Committee on Shareholder Responsibility. Now the Executive Committee, acting for the Corporation, has reported on the advice it received from its Advisory Committee and the actions it has taken—all of them essentially consistent with its advisers' recommendations—on stockholder petitions before four corporations in which M.I.T. owns stock this spring. The four are:

☐ *Gulf Oil Corp.* A shareholder resolution asked disclosure of Gulf's activities in Portugese Angola. The Advisory Committee recommended a vote with management, against the resolution, because Gulf had already agreed to provide the information.

The shareholder committee sponsoring the resolution then asked the M.I.T. Executive Committee a more general question: "Does a corporate management have concerns and responsibilities beyond the considerable economic ones, in places such as Angola where an established (and colonial) political power may be at variance with the expectations of the masses of the people?"

M.I.T.'s Advisory Committee answered yes: shareholders may indeed ask about the "objectives and means" of a company's "political involvements." And in this case, the Committee said, it hoped Gulf's management would "use its considerable economic leverage to promote social and political change."

☐ *Ford Motor Co.* One shareholder resolution called for broadening the Board of Directors by adding "women and representatives of employee organizations, consumers, and minority groups." The M.I.T. Committee returned to an earlier judgment to recommend a vote against the resolution, saying that election of "representatives, *per se,* of minorities, labor, and other special interest groups is (not) in the interest of effective corporate activity."

On another shareholder resolution, calling on Ford to provide certain specified information on its annual report, the Committee recommended that M.I.T. abstain from voting and instead write to Ford its suggestion that all corporations should "find better ways of presenting to the public what they are doing in . . . areas of social responsibility."

☐ *Goodyear Tire and Rubber Co.* The M.I.T. Shareholder Responsibility Committee recommended an affirmative vote on a resolution asking for information about operations in South Africa.

The Executive Committee agreed that M.I.T. "as a stockholder ought to be prepared consciously to advocate corporate actions applying affirmative, fair, and progressive employment practices to the extent permitted by South African law even if the consequence may include a loss of some potential profit." But because the Executive Committee could not act before the Goodyear meeting, it did not support the Advisory Committee's recommendation.

☐ *General Motors Corp.* On two shareholder proposals—one to appoint a committee to study the advisability of dividing G.M. into two or more separate corporations and the other for a series of open meetings of the G.M. Public Policy Committee—M.I.T. voted its shares with management, in opposition.

On the third of the four substantive shareholder proposals, asking the Corporation to present for Directors "a slate of qualified nominees without limitation as to sex," the Advisory Committee could see no basis for opposition and so recommended a vote with the shareholders and against management.

On a proposal for disclosure of South African operations, the Advisory Committee repeated its recommendation stated in the case of Goodyear.

Walter L. Milne, Assistant to the Chairman of the Corporation who provided staff support to the Advisory Committee on Shareholder Responsibility, told *Tech Talk* in May that the decisions of the Executive Committee "reflect the conviction that M.I.T., as a large institutional investor, must be concerned not only with maximum return for educational purposes but with issues of social responsibility . . ."

W. G. Austen

W. Van A. Clark

R. A. Donnellan

W. H. K. George

P. V. Keyser

B. M. Kerr

R. Landau

C. W. Murchison

I. M. Pei

P. P. Shepherd

Corporation Confirms Ten Members; Largest in History

Ten alumni—eight of them new to the Corporation—have been elected to new terms as members of the governing body of M.I.T. Their elections, confirmed to be effective July 1 by the Corporation at its June meeting, bring the total membership of the M.I.T. Corporation to 87, the largest number in its history.

The new Corporation members are:

☐ Dr. W. Gerald Austen, '51, Chief of Surgery at Massachusetts General Hospital and Professor of Surgery at Harvard Medical School. Dr. Austen attended Harvard Medical School following undergraduate work in mechanical engineering at M.I.T., and he now holds a five-year Term Membership on the Corporation.

☐ W. Van Alan Clark, Jr., S.M.'42, President and Chairman of the Board of Sippican Corp. and Chairman of the Board of General Electronics Laboratories. Mr. Clark taught at M.I.T.'s Sloan School of Management from 1946 to 1958 and during the last two years of that period served as Assistant Dean. He entered the school in 1941 after graduating from Williams College; his election is for a five-year Term Membership.

☐ Rebecca A. Donnellan, '72, who received M.I.T.'s S.B. degree in management at the Graduation Exercises on June 2. Miss Donnellan's election is to a five-year term as a Representative from Recent Classes, for which she was nominated by members of the classes of the last three years. As an M.I.T. undergraduate, she has been active in Institute affairs affecting women and has had parts in studies of university investing and social responsibility, alternative federal policies for funding research and development, and the societal implications of corporate decisions.

☐ W. H. Krome George, '40, President of the Aluminum Company of America. A graduate of M.I.T.'s Sloan School of Management, Mr. George joined Alcoa in 1942, became Vice President in 1964 and President in 1970; he is a member of the President's Commission on American Shipbuilding. His election is to a five-year term membership.

☐ Breene M. Kerr, '51, Senior Partner in the Resource Analysis and Management Group, Inc., Oklahoma City. Already a term member of the Corporation, Mr. Kerr was elected to an ex-officio chair as President of the Alumni Association. A graduate of M.I.T. in geology, Mr. Kerr is a long-time officer of Kerr McGee Oil Industries; he was from 1964 to 1967 a principal officer of the National Aeronautics and Space Administration.

☐ Paul V. Keyser, Jr., '29, former Executive Vice President of Mobil Oil Corp. Mr. Keyser was nominated for a five-year term on the M.I.T. Corporation by fellow-alumni following two years of service as President of the Alumni Association. He is a graduate of M.I.T. in chemical engineering with both S.B. and S.M. (1930) degrees, and he joined Mobil Oil Corp. immediately upon leaving the Institute.

☐ Ralph Landau, Sc.D.'41, President of Halcon International, Inc. Mr. Landau, formerly an engineering executive with M.W. Kellogg Co. and later Executive Vice President of Scientific Design Co., Inc., joined Halcon in 1963 as President. He came to M.I.T. for graduate work in chemical engineering following study at the University of Pennsylvania; his election is to a five-year term.

☐ Clint W. Murchison, Jr., S.M.'44, Partner in Murchison Brothers, Dallas. Mr. Murchison came to M.I.T. from Duke University to study mathematics; he is widely known as owner and Chairman of the Board of the Dallas Cowboys football team.

☐ Ieoh M. Pei, '40, Principal in I. M. Pei and Partners. Mr. Pei came to the U.S. in 1935 to study architecture at M.I.T.; he later studied at Harvard and practiced architecture in Boston, New York, and Los Angeles before founding his own firm—now one of the nation's largest and most distinguished—in 1955.

☐ Paul P. Shepherd, '53, Senior Vice President of Cabot, Cabot and Forbes. Mr. Shepherd, active in M.I.T. alumni affairs for many years, is based in San Francisco; his academic work at the Institute was in civil engineering, and he has a long-time association with CC. & F.

"The Future Is Not The Way It Used To Be"

The labor-intensive service industries will be the focus of economic growth in the U.S. for at least the next 15 years. Yet such industries persist in transplanting themselves into the suburbs, away from the people who most need their jobs.

The U.S. is far from meeting its people's expectations for the speed, comfort, and reliability of public transportation. Yet we use our public funds to support competing travel modes because we cannot choose between them.

The contributions of future science and engineering to the housing industry will be effective less because they provide new technology than because they affect the kind and standards of housing for which there is demand. Already we know how to make impressive savings by mass producing housing, and we need thousands of new housing units; but we cannot guarantee builders the market they need to make assembly lines profitable.

The cost of good medical care spirals ever-higher, and we are determined to consider it a right, not a privilege. But only 5 per cent of the cavities in U.S. teeth are ever filled.

Anomalies like these were in every speaker's script at a seminar on technological opportunities in the 1970s conducted late this spring by the M.I.T. Alumni Center of New York. David G. Wilson, Professor of Mechanical Engineering, generalized them as examples of our need to "internalize the externalities," to make decisions on the basis of true values and true costs instead of emotionalism and hidden subsidies. And John F. Collins, Professor of Urban Affairs, added the powerful force of system analysis important, he said, to describe solutions in terms of their present and future effects not only on the problems to which they are addressed but on the larger system with which the problems are interdependent. Only this way, he

said, can we improve upon our current "intuitive system of satisfying the most urgent perceived need."

A simple, optimistic view of problems and solutions came from William T. Magruder, Special Consultant on Technology to President Nixon: 1972 will be a "unique year for technology." This is true because, in an election year, the President for the first time in history has issued a special message on technology. Technological priorities thus become a subject for debate in the campaign and decision in the election. And for the first time in recent history—now that the spurious issues on which the S.S.T. debate was resolved are clearer to all observers, said Mr. Magruder—there is wide agreement on technological priorities among members of the House and Senate.

Only an hour later Professor Collins, advocating system analysis of complex urban and national problems the solutions to which may well turn out to be counterintuitive, told his audience that there is "not a person in America today who can predict with any confidence the consequences of any action that we might legislate."

Summarizing the day's proceedings, Paul E. Gray, '54, Chancellor, found himself perplexed—"The future isn't what It used to be," he said.

Other speakers at the seminar included Edward Mayers, Senior Economist at McGraw Hill Publishing Co., who gave predictions of future G.N.P. and the contributions to it of service, durable manufacturing, and non-durable manufacturing industries; William J. Ronan, Chairman of New York's Metropolitan Transportation Authority, on transport policy; Joseph H. Newman, Vice President of Tishman Research Corporation, on technology for housing; and Irwin W. Sizer, Dean of the M.I.T. Graduate School, on technology for health services.

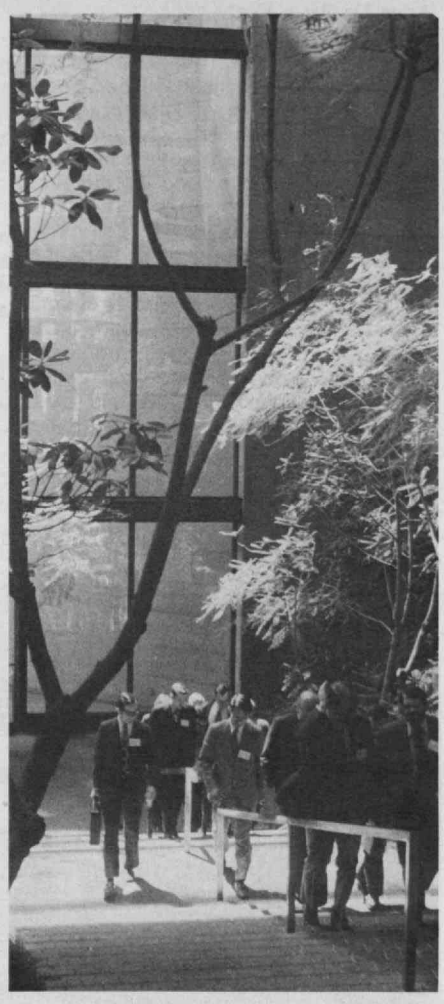
A New Undergraduate Major

Beginning this fall, there will be an even 25 courses at M.I.T. The twenty-fifth is a new S.B. program in interdisciplinary science.

The new program takes the place of Course XII-B, an interdisciplinary program in physical sciences offered for the past three years in the Department of Earth and Planetary Sciences.

Each student in Course XXV will arrange his own curriculum in consultation with his adviser and subject to the approval of a faculty advisory council. Each student must satisfy the General Institute Requirements and in addition must plan and complete a coherent 84-unit set of science subjects beyond the introductory level.

The 84 units correspond to the core program in other majors; they may be tailored to the student's individual needs, but they must be aimed at some well-defined educational goal.



Are we entering "the Meadows-Forrester Century"? Yes, in the sense that the rules are changing; but not necessarily, in the sense that new concepts of growth and its limits emanating from M.I.T. demonstrate the issue but not necessarily the character of the future. These are scenes during an Alumni Center of New York seminar whose deliberations early this spring may be paraphrased in that sentence. (The photo above shows William T. Magruder, Special Consultant to President Nixon, visiting with Paul E. Gray, '54, Chancellor of M.I.T., during the seminar luncheon.)

Dr. C. B. Eisenberg *J. H. Hollomon*

A Woman to be Dean for Student Affairs at M.I.T.?

True.

She is Dr. Carola B. Eisenberg, who has been a member of the psychiatric staff of the M.I.T. Medical Department since 1968 and in that period has also taught freshman seminars and worked with students and faculty in many matters related to student counseling and student life.

Dr. Eisenberg succeeds Professor J. Daniel Nyhart, who will work as Special Assistant to the Chancellor to coordinate law-related studies at M.I.T. and to develop preprofessional non-curricular programs in such fields as law, public administration, education and medicine in which substantial numbers of students are now seeking to focus their undergraduate education. He will also resume teaching in the Sloan School of Management.

In announcing the change, President Jerome B. Wiesner said Dean Nyhart "has served the Institute with distinction, devotion, and unbounded energy" as Dean for Student Affairs since 1969.

Dr. Eisenberg earned her M.D. degree from the University of Buenos Aires, Argentina, which is her native land; she took specialty training in psychiatry at the University of Maryland and the Johns Hopkins Hospitals and later joined the faculty at Johns Hopkins University's School of Medicine. She describes M.I.T. students as "an exciting, vibrant group of people," and at a press conference with student publications she said she was "looking forward to a closer association with student activities and to learning a new career and profession."

Center for Policy Alternatives

J. Herbert Hollomon, '40, Consultant to the President and Provost of M.I.T. since 1970, has been named Visiting Professor of Engineering and Director of a new Center for Policy Alternatives in the M.I.T. School of Engineering.

The Center's role, says Dr. Alfred H. Keil, Dean of the School of Engineering, will be to study "substantive issues related to society, particularly those in which technology and engineering could play significant roles." It will draw talents from various disciplines throughout M.I.T. in the common cause of finding alternatives to solve critical societal problems in which technology appears to play a significant part.

Responding to the announcement of his new assignment, Dr. Hollomon proposed that studies will begin at once on such topics as national technology policy, the supply and demand for professional manpower, special requirements of the service sector such as those of education, energy supply and policy, and public communications requirements and improvements.

Dr. Hollomon studied metallurgy at M.I.T. (S.B. 1940, Sc.D. 1946), soon thereafter joining the General Electric Co.; he was Director of Research and Head of G.E.'s Central Engineering Laboratory when called by John F. Kennedy to become Assistant Secretary of Commerce for Science and Technology in 1961, and he served as President of the University of Oklahoma from 1968 to 1970.

How To Be a Sister for 32 Brothers—and Like It

Mariette Howell has just finished carving a niche for herself in M.I.T. history.

This year she has been the first single woman to serve as a graduate resident in an M.I.T. male dormitory—in this case, MacGregor House.

As a resident, Miss Howell has had no formal responsibilities, except to be there in case of need. But even that can be difficult: "Students might act as if something is wrong, but they don't usually come out and tell me their problems. I have to ask around and find out myself," Miss Howell told *Tech Talk* this spring. "But I think it's good for kids to have someone near their own age to talk to," she said.

And she thinks a woman is good for the job, too. "Many guys who come to M.I.T. have spent all their time in libraries instead of social things, so it's good for the graduate resident to have a background different from theirs."

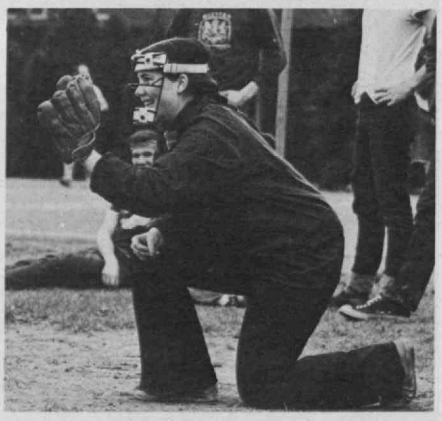
Miss Howell thinks she has been successful in MacGregor because her door is always open and she's always available to talk about problems. "In the beginning I was a girl first, then a person; now they consider me a person first, and then a girl."

MacGregor House residents describe Miss Howell as "a big sister" or "like a mother." But they all seem to agree on approving her cakes and brownies, which are a weekly project. Indeed, according to Miss Howell, the maximum life of her cakes has been seven minutes.

Reason enough for a second MacGregor entry to ask for a woman graduate resident next year, and students are now being interviewed by the Dean for Student Affairs for that job.

Being a MacGregor resident has its problems, too. Miss Howell finds her social life a bit different: she has 32 "younger brothers" to verbally approve or disapprove of her dates—and if the disapproval is strong enough, the young man is greeted with a shower of water balloons on his second visit.

Other complications, too. One night Miss Howell was doused with water—a water fight—just an hour before a big date was due to arrive; 15 minutes later, just as the damage was repaired, it happened again—and so on for the next hour. And when things are dull at MacGregor there is "bathtubbing"—being dropped fully dressed into a tub full of water. How many times? "I can't count them all."



Mariette Howell, a graduate student in management who came to M.I.T. from Wellesley in September, 1971, is the first single woman to serve as a graduate resident in an M.I.T. male dormitory. She's obviously popular (she serves as catcher on the MacGregor intramural softball team), and of all the ways to live at M.I.T., she says, "I like this one best." (Photos: Margo Foote)

This small hovercraft, flying low across Briggs Field in a snowstorm of its own making, is the principal apparatus in an undergraduate aeronautical engineering project. It was built from a kit by Michael A. Kotch, '72, and Wilhelm Daida, '72, and after its inaugural flight (above) was used for research on performance and stability. (Photo: Margo Foote)

Flying Low in a Snowstorm

It sped noisily across Briggs Field, spinning and sliding in a great white cloud; and though it left occupants and bystanders caked, it put hardly a mark on the powdery fresh snow.

The contraption being demonstrated was a small hovercraft, and at the controls were a pair of students—the happy investigators in one of the year's more spectacular undergraduate projects.

In looking around for a research topic for their aeronautical engineering project laboratory, seniors Michael A. Kotch and Wilhelm Daida found that their department had on hand a small hovercraft kit which was given to the Institute last year by Enrique L. Kilayko, S.M.'60.

With some help from fraternity brothers (Phi Mu Delta) John P. Caesar, '73, and Robert P. Batzinger, '75, the students assembled their plastic-and-plywood craft in eight days. The Aeronautical Engineering Department's Experimental Projects Laboratory provided a snowmobile engine (not included in the kit) for power.

But the project is not just to make local snowstorms on Briggs Field. Messrs. Daida and Kotch have installed instrumentation to study various performance and stability effects. To measure yaw they have attached precision accelerometers, whose output is recorded for later analysis. There is also a tachometer to measure the fan speed, and this can be correlated with ground speed measurements made by a suspended wheel.

Graduate Fellows' First Choice

Over 14 per cent of the 550 university seniors who have won highly-coveted National Science Foundation fellowships for graduate study in science, mathematics, and engineering next year will use them to enter the M.I.T. Graduate School. And some 13 per cent of 448 renewal fellowships granted by N.S.F. for students with two-year grants came to M.I.T. graduate students for third-year support.

In all, 137 of the 998 students supported for graduate study by the National Science Foundation next year in science, mathematics, and engineering will be at M.I.T. Though the N.S.F.'s total fellowship program is reduced by 150 from its current-year level, the number of students using fellowships at M.I.T. will remain about constant, according to Irwin W. Sizer, Dean of the Graduate School. Measured in this way, graduate departments at M.I.T. appear to be the most popular in the nation, he said.

From Coaches Barry To O'Brien: Look, Ma, No Scholarships!

At the end of the season in March, John G. Barry, who has guided M.I.T.'s popular and successful basketball teams for 13 years, put away his whistle and moved, full time, to his front office desk—as Assistant Director of Athletics. He did so because "this is a crucial stage in the development of the M.I.T. athletic program," he told the *Boston Herald-Traveller,* "and there just aren't enough hours in the day for me."

Mr. Barry will be succeeded as basketball coach by Francis J. O'Brien, who has been his assistant on the basketball courts and is the Head Coach for baseball.

Mr. Barry told Brian Beaulieu of the *Herald-Traveller* that he is convinced the M.I.T. approach to intercollegiate athletics ("low key, no scholarships") is right. "I haven't seen the problems many other coaches have. When a boy plays basketball—or any other sport—at M.I.T., it's because he really wants to. We don't recruit talent. I've always thought of myself as a teacher rather than a coach."

The same ideas came from Mr. O'Brien three days later in an interview with Joe Concannon of the *Boston Globe.* "If I had to go into a recruiting situation again, I'd give it up," he said. "This is a better approach. You don't get the benefits of going out and getting the big guy. As a result, you may sacrifice a winning season. But if you're patient enough, you can win.

"One of the good factors here is that, when a player comes out for a sport, he does so because he wants to play. You get kids with limited backgrounds, but—by the time they're seniors—they frequently make it."

Bassoons and a Happy Hour

One day this spring *Tech Talk*—M.I.T.'s house organ—did a census: 172 posters and announcements on a single bulletin board, and 30 "public-public" bulletin boards in the Institute's main corridors.

"Public-public"? That's the designation of Nora Rothman of the M.I.T. Planning Office. More than 500 people pass through the main first-floor corridors of M.I.T. every hour on a business day, and bulletin boards there are definitely "public-public." Elsewhere, bulletin boards are mostly for departments and their students, and those are "public-private."

The 172 posters included travel to the Bahamas, a bassoon for sale, Hasty Pudding Theatricals at Harvard, a ski lodge for rent, happy hour at K-K-K-Katy's, concerts, lectures, meetings, movies, folk fiddle lessons, Fit for Life exercise classes, a ride wanted to Oklahoma, *Boston After Dark*'s Great Earth Lover's Ecology Contest, typing services, a religious newsletter called *Fatima Findings* . . . a very distant time from the day when everything required approval from the Dean's Office, or the Undergraduate Association, or whoever. Mrs. Evelyn Reiser, Secretary in the U.A. office, admitted to *Tech Talk* that the bulletin boards "are handled in a fairly easy-going manner," and *Tech Talk* itself concluded that they are governed "by Newton's law of gravity—what goes up must eventually come down."

You can learn a good deal about the M.I.T. community's passions by reading its bulletin boards; one of the 30 on the main corridors displayed 172 posters, cards, and notices one day this spring when Tech Talk *made a survey. (Photo: Margo Foote)*

A Traditional Awards Convocation

In the midst of a troubled spring (*see* Technology Review *for June, pp. 74-76)* there was still time for the Institute's traditional honors to outstanding members of its community. Politics and nature conspired to make possible a pleasant and uninterrupted Awards Convocation among the new foliage and flowers in the Great Court on May 11.

As always, the highlight of the occasion was the presentation by Mrs. Karl Taylor Compton of the Compton awards, established in 1953 in honor of her late husband, ninth President of M.I.T., and to recognize "outstanding contributions in promoting high standards of achievement and good citizenship within the M.I.T. community."

The 1972 recipients were:

☐ George Barstow Flint, '72. "An energetic innovator, he helped create new directions in educational experiments and define the relevance of engineering in an age of new social values."

☐ Bruce King Hamilton, '69. "Scholar, musician, and concerned citizen, he took leadership in creating new interdisciplinary programs and focusing M.I.T.'s energies on the problems of our natural environment."

☐ John Emil Krzywicki, '72. "His tireless service in the operations of student government and the development of fair judicial processes has benefited a whole kaleidescope of student activities."

☐ William Murray Mack, Jr., '68. "Teacher, adviser, resident tutor, and leader of the graduate community, he has brought responsible judgment and concrete improvements to a vast range of student activities."

☐ Alexander George Makowski, Jr., '72. "His detailed and thoughtful investigations of educational philosophy, Institute governance, and the scientific culture of M.I.T. have brought new depth to student journalism and provoked the community to reexamine its values."

☐ Charles Edward Mann, '72. "His mature and reasoned insights have added new dimensions to discussions of education, student environment, and technology and culture, and proved the value of student participation in faculty deliberations."

☐ *Ad Hoc* Committee on the Role of Women at M.I.T., accepted by Paula Joyce Stone, '72. "Through their efforts to study and satisfy the special needs of women students, they fostered a more diverse and exciting environment for all at M.I.T."

☐ Alpha Chi Chapter of Alpha Phi Omega, National Service Fraternity, accepted by Robert Leo Dwyer, '72. "In generous service to both the Institute and the surrounding community, they helped make M.I.T. a more gracious host and concerned friend to all."

The Everett Moore Baker Award for Outstanding Undergraduate Teaching is usually presented to a young faculty member "in recognition of extraordinary interest and ability in inspiring undergraduate interest in and understanding of academic work." This year, it was presented to a married couple, Suzann Thomas Buckle and Leonard Gould Buckle, '64, two graduate students who are Assistant Directors of the Undergraduate Program of the Department of Urban Studies and Planning.

A New Life for Phi Beta Kappa

"Basically you have a flux of electrons . . ."

An unlikely dinner conversation between M.I.T. male and coed—at the second annual Phi Beta Kappa initiation ceremonies? Nowhere else.

Of 58 initiates this year, 28 were majors in physics and 12 were coeds. All had "cums." for their M.I.T. careers of 4.8 or over (5.0 = straight A).

Reciting a brief history of Phi Beta Kappa, Sanborn C. Brown, Associate Dean of the Graduate School who serves as Secretary of M.I.T.'s chapter, noted that P.B.K. are the initials of a Greek phrase freely translated to "love of wisdom is the guide for life."

Having finally achieved its Phi Beta Kappa chapter just a year ago, M.I.T. now has some plans for the life of the national honorary in the liberal arts. M.I.T. is the only institute of technology whose graduates in the humanities and sciences (with S.B. degrees) can officially be elected to Phi Beta Kappa membership; the problem now is to convince the national headquarters that every M.I.T. graduate, including those in engineering, architecture and planning, and management, has in fact achieved a liberal education.

Research on Housing Design

A proposal to ask poor people in Boston what they like and do not like about the low-income housing projects in which they live has brought the 1972 William H. Scheick Research Fellowship of the American Institute of Architects to James Wilson, Jr., a first-year graduate student in the M.I.T. School of Architecture and Planning.

Mr. Wilson will use the $2,500 fellowship for his research, comparing the design of the low-income residential environment with the satisfaction users derive from the resulting environment. In the end, says Mr. Wilson, he hopes to give future designers a set of guidelines they can use in planning housing projects to best satisfy the wants of those who will live in them.

Integers Alphabetized

Given all the numbers from 0 to 1,000 written in words, which is first in alphabetical order? Next? Tenth? 1000th?

The answers: eight, eight hundred, eight hundred eighty-one, and zero.

They come from a little white book with the enigmatic title *Alphabetic Number Tables,* which made its appearance at M.I.T. this spring. It is a unique creation —but one that leaves no one wondering why it has never been done before.

On 36 pages between its covers, this book lists all the integers from zero to 1,000 in two alphabetical sequences—one in English words, "zero" to "one thousand," and one in Roman numerals, I (there is no zero) to M.

The little white book, written almost entirely by computer, is the work of the imagination and computer-programming talents of four students in Professor Gian-Carlo Rota's "Surveys in Higher Mathematics" class: Daniel E. Bloom, '72, Richard G. Collarini, '72, Radia J. Perlman, '73, and Anthony G. Zawadski, '73.

More than chance led the authors to publish their book on April 1; with tongue in cheek, they said in a computer-printed forward, "Our humble enterprise is motivated by an honest desire to make this work an invaluable aid to the teaching profession, the mathematician, the physical scientist, the engineer, the statistician, and to many others whose use of these pages will facilitate solution of challenging problems in all intellectual endeavours *(sic)."*

Poking some April Fools' Day fun at the M.I.T. community, four students in "Surveys in Higher Mathematics" showed up in the Lobby of Building 10 on April 1 this year to sell a computer-printed little white book. "It gives us great pleasure," they said in their preface, "not unmixed with profound emotion, to at last make public these alphabetical tabulations of the natural integers, ordered both in English literation and in Roman numerals." Curious readers may order copies from Technology Review *for 50 cents each. (Photo: Margo Foote)*

M.I.T.'s heavyweight crew season started badly; after leading Northeastern for most of the season's first race, a signalling error threw the boat into confusion. But thereafter things went better—and there were frequent dunkings for Cox David S. Burns, '72. Boston Globe *photographer Danny Goshtigian caught Robert J. Tronnier, '73, at a rare moment in the hurdles: losing to Donald Slevin of Tufts. But the hero of M.I.T.'s spring athletic campaigns was pitcher Alan F. Dopfel, '72, who shattered all varsity baseball records and then signed with the California Angels; he tested his arm in the Fenway Park dugout (below) and then went off to play in Shreveport, La., with the Angels' farm club. (Photos:* Boston Globe *and Sheldon Lowenthal, '74)*

A Baseball Record, and The Resurgence of Crew

On April 26 Alan F. Dopfel, '72, pitched the first no-hit game in varsity baseball history at M.I.T. It was against Brandeis, and the final score was 6-0. A week later he allowed only one hit and had 19 strike-outs to his credit—another M.I.T. record—in a game against Bates.

Mr. Dopfel's performance was the highlight of a spring sports season that kept M.I.T. sports-watchers on the edges of their seats:

☐ The heavyweight crew made a poor start for the best season in recent history: leading Northeastern in the second race of the year by nearly a length 100 meters from the finish, cox David S. Burns, '72, asked for a sprint. Jere B. Leffler, '73, heard the command, but the man behind him didn't. The result was confusion, and Northeastern went on to win by nearly a length. Joe Concannon of the *Boston Globe* said at the time it would have been "the upset of the young season"; he didn't know then that Northeastern would go on to unseat reigning Harvard for the Eastern Championships as the season ended.

Two weeks later the heavyweight crew clung to a half-length lead for 2,000 meters to win the 12th annual Cochrane Cup regatta on May 6, defeating Wisconsin and Dartmouth. The "heavies" also scored victories over Columbia and from Princeton (the first time in seven years). And on May 20 they won the Packer Cup by defeating Syracuse and Dartmouth at Syracuse.

☐ Robert J. Tronnier, '73, confirmed his position as "the reigning New England indoor and outdoor hurdle king" by winning two races in the Greater Boston Track Championships; he was beaten only once in the 120-yard high hurdles during the regular season.

☐ Rated fourth entering the Women's Northeast Intercollegiate Rowing Sprints at Old Lyme, Conn., M.I.T.'s coed crew came away from the 1,000-meter race in third place behind Princeton and Radcliffe; *The Tech* admitted that they "show great promise for the future."

☐ David R. Wilson, '74, tied the M.I.T. varsity pole vault record (15'2") and set the meet record to help M.I.T. win fourth place among 19 colleges and universities at the Eastern Intercollegiate Track Meet at Bowdoin.

☐ M.I.T. dominated New England spring dinghy-sailing, winning the Friis Regatta, a New England states intersectional meet, and then continuing to win the New England Championships. The coed sailors meanwhile had finished second—behind Radcliffe—in the Women's New England Sailing Championships.

Retirements: Saying Goodbye to 119 Friends "with Great Sadness"

President Jerome B. Wiesner found it "a touching and sad occasion" when he was called on to honor the 119 Institute employees, staff, and faculty who retired on July 1 at the annual banquet. The list includes a number of administrative officers as well as nine distinguished members of the faculty.

They are: Robley D. Evans, Professor of Physics; Harold W. Fairbairn, Professor of Geology; Roland B. Greeley, Director of Admissions and Professor of Regional Planning; Everett E. Hagen, Professor of Economic and Political Science; Gyorgy Kepes, Institute Professor and Professor of Visual Design; Deane Lent, Professor of Mechanical Engineering; Klaus Liepmann, Professor and Director of Music; Herbert H. Uhlig, Professor of Metallurgy; and Robert S. Woodbury, Professor of the History of Technology.

Dr. Evans, Director of the Radioactivity Center, retires after 38 years at the Institute. He pioneered in the study of the effects of radium on the human body and established the world's first academic course in nuclear physics. In addition, he was responsible for the establishment of the Institute's Markle Cyclotron Laboratory in 1938. Born in University Place, Neb., Dr. Evans attended the California Institute of Technology (B.S. 1928, M.S. 1929, and Ph.D. 1932), came to M.I.T. as Assistant Professor of Physics in 1934, and was promoted to Associate Professor in 1938 and Professor in 1945. Dr. Evans is now President-Elect of the Health Physics Society and will succeed to the presidency in June.

Dr. Fairbairn, a specialist in petrology, geochronology and petrofabrics, has been associated with the Institute since 1931. Born in Ottawa, Ontario, he received the B.Sc. degree at Queen's University in 1929 and the M.A. (1931) and Ph.D. (1932) degrees from Harvard University. His first association with M.I.T. was in 1931 as a part-time graduate student. He did post-doctoral work at Innsbruck, Gottingen, and Berlin from 1932 to 1934, was an instructor at Queen's University in Canada from 1934 to 1937, and in that year he was appointed Assistant Professor of Geology at M.I.T.; he became Associate Professor in 1943 and Professor in 1955.

Dr. Hagen, a specialist in the economic and social development of emerging nations, was for two years until early in 1972 Director of the M.I.T. Center for International Studies. Born in Holloway, Minn., he studied at St. Olaf College (B.A. 1927) and the University of Wisconsin (M.A. 1932, Ph.D. 1941). He joined M.I.T. in 1953 as a senior staff member at C.I.S., was Visiting Professor of Economics from 1953 to 1959, and became Professor of Economics in 1959 and Professor of Political Science in 1965. During the 1972-73 academic year he will be on a deferred sabbatical at the East-West Center in Hawaii.

Professor Kepes is an internationally known artist whose special interest has been the visual forms associated with science and engineering. He has been Director of the Center for Advanced Visual Studies at M.I.T. since its organization in 1967, and he will continue in that role following his retirement from the teaching staff on July 1. A native of Hungary, he studied at the Academy of Fine Arts in Budapest, later joined the Bauhaus group in Berlin, and came to the U.S. in 1937 to head the Light and Color Department of the Institute of Design in Chicago. Professor Kepes came to M.I.T. in 1946, was appointed Professor in 1949 and Institute Professor in 1970, and has had a large number of exhibitions and honors in those years.

Professor Lent has specialized in engineering drawing, design and graphics. Born in Ganonoque, Ontario, he studied at Dartmouth College (A.B. 1930) and the Lowell Institute School before joining the M.I.T. staff as instructor in mechanical engineering in 1938. He was appointed Assistant Professor in 1944, Associate Professor in 1963, and Professor in 1969.

As Director of Music at M.I.T. for 25 years, Professor Liepmann has led in developing the music program into a valuable and active part of M.I.T.'s scheme of general education. He is the founder and conductor of the Choral Society and conductor of the Glee Club, and for many years he was conductor of the M.I.T. Symphony Orchestra. A native of Kiel, Germany, Professor Liepmann began studying violin at the age of six. At 18 he entered the Academy of Music in Cologne, where he became the protege of the celebrated conductor Karl Muck. After coming to the United States in 1933, he was at Yale University before joining the M.I.T. faculty as Assistant Professor of Humanities and Director of Music in 1947; he was promoted to Associate Professor in 1951 and Professor in 1956.

Professor Uhlig is widely known as an expert on corrosion and electrochemistry. His direction of M.I.T.'s work in the field of corrosion began in 1936 when he was appointed Research Associate at the Institute in charge of the M.I.T. Corrosion Laboratory, then established to investigate pitting corrosion of stainless steels. Born in Haledon, N.J., Professor Uhlig received the Sc.B. degree from Brown University in 1929 and the Ph.D. degree from M.I.T. in 1932. He joined the staff of the General Electric Research Laboratory in 1940 but returned to the Institute in 1946 as Associate Professor of Metallurgy. In 1953 he was promoted to Professor.

Professor Woodbury has specialized in tracing the development of technology in the U.S. as interwoven with economic and social influences. Before World War II he initiated a brief program in the history of technology at the Institute and has since expanded it into several courses. A native Bostonian, Professor Woodbury received the S.B. degree in mathematics from M.I.T. in 1928 and the A.M. from Harvard in 1936. He joined the Institute staff as instructor in English and history in 1929, was promoted to Assistant Professor of the History of Science in 1936 and in 1946 became Assistant Professor of English and History. He was appointed Associate Professor of Humanities in 1959 and Professor of the History of Technology in 1963.

Professor Greeley was a member of the Department of City and Regional Plan-

R. D. Evans

H. W. Fairbairn

R. B. Greeley

E. E. Hagen

G. Kepes

D. Lent

K. Liepmann

H. H. Uhlig

R. S. Woodbury

ning (now the Department of Urban Studies and Planning) for 16 years before his appointment to Director of Admissions in 1961. He is widely known in the planning profession and has served as consultant to numerous cities and agencies in this country and abroad. A native of Lexington, Mass., Professor Greeley studied at Harvard (B.A. 1931, M.C.P. 1961), was appointed Assistant Professor of Regional Planning at M.I.T. in 1945, and became Associate Professor in 1947. From 1951 to 1952 Professor Greeley served as Acting Head of the Department of City and Regional Planning. He was promoted to the rank of Professor in May, 1961, and in June of that year was named Director of Admissions. He has served on a number of faculty committees, giving special attention to undergraduate policy, student environment and student aid.

Among staff and administration retiring who will be well known to many *Technology Review* readers are John L. Ayer, Special Assistant for Grounds; Alan C. Bemis, S.M.'30, Senior Research Associate in Meteorology; Robert P. Cavileer, Cryogenic Laboratory; Henry Morss, Jr., Ph.D.'34, Administrative Officer for the Department of Earth and Planetary Sciences; Ralph A. Sayers, Assistant Director of the Research Laboratory of Electronics; Elwood W. Schafer, '32, Administrative Officer of the Center for Materials Science and Engineering; Albert F. Sise, Associate Director of the Office of Personnel Relations; Arthur B. White, Manager of the Office of Laboratory Supplies; and Patrick Youtz, '49, Lincoln Laboratory.

President Wiesner, recognizing their uncounted total years of "faithful service to M.I.T.," said he found "saying goodbye to so many friends something one does with great sadness." The record—exactly 50 years of service to the Institute—was held by Mr. White.

The Billard Award—for Music

Klaus Liepmann, Professor of Music, and the M.I.T. Choral Society, which he directs, staged their own celebration of Professor Liepmann's retirement this spring (*see above*): a performance of Bach's *Passion According to St. John.* Louis Snyder, writing for the *Christian Science Monitor,* called the performance "majestic in concept, attentive to detail, and musically solid."

And, he said, "as might be expected, everyone performed with particular devotion."

The Institute's devotion to Professor Liepmann was expressed in a standing ovation, in which the chorus shared, and at a reception later when President Jerome B. Wiesner gave him M.I.T.'s Gordon Billard Award for his contribution to the Institute's musical life during 25 years as Director of Music. "From the beginning," said Dr. Wiesner, "it was the conception of Klaus Liepmann that theory and practice, the learning about and the making, of music are indivisible. Thus curricular and extracurricular became one."

Scrimshaw is First Killian Laureate

Dr. Nevin S. Scrimshaw, Head of the Department of Nutrition and Food Science, is the first recipient of the James R. Killian, Jr. ('26) Faculty Achievement Award.

The faculty established the award last year as a permanent tribute to Dr. Killian, tenth President of the Institute from 1948 to 1959 and Chairman of the M.I.T. Corporation from 1959 until 1971. Its purpose is "to recognize extraordinary professional accomplishments" by M.I.T. faculty members.

Dr. Scrimshaw, who receives a $5,000 honorarium, will hold the title, "Killian Award Lecturer" in 1972-73 and during that year is invited to present one or more lectures on his own professional activities.

In announcing the selection of Professor Scrimshaw, Professor Morris Halle, Chairman of the Selection Committee, reported the Committee's judgment that the first recipient "should be a person of outstanding professional accomplishment whose contribution, like that of Dr. Killian, lies in an area where science and public affairs intersect." He cited Dr. Scrimshaw's contributions to the study of protein malnutrition in children and, in general, his contributions to understanding "the relationship between nutrition and the mental and intellectual functioning of man."

Mauze Professor

Dr. Esther M. Conwell, a distinguished solid state physicist who is Manager of the Physics Department at the GTE Laboratories' Bayside, N.Y., Research Center, has completed two months as Abby Rockefeller Mauze Visiting Professor in the M.I.T. Department of Electrical Engineering. During her period as Mauze Professor, Dr. Conwell delivered a series of technical colloquia and participated in other teaching and research activities in the Departments of Electrical Engineering and Physics.

Dr. Conwell studied at Brooklyn College, the University of Rochester, and the University of Chicago; she has taught at Brooklyn College and before joining GTE she was affiliated with Bell Telephone Laboratories.

Green Professor

Samuel J. Mason, Sc.D.'52, Professor of Electrical Engineering and Associate Director of the Research Laboratory of Electronics, will be Cecil H. Green Professor at M.I.T. for 1972-1974. He becomes the second holder of the chair established by Mr. and Mrs. Cecil H. Green ('23) "to help individual members of the electrical engineering faculty move into new areas of research."

Professor Mason will use his two-year tenure of the Green Professorship for research on problems of pattern recognition and applications to automation. He succeeds Peter Elias, '44, Professor of Electrical Engineering.

Professor Mason has been a leader in developing experimental reading machine systems for the blind, and he is well known for research on problems of character recognition by machines, real-time data processing, and the psychophysics of tactile and auditory displays. His teaching assignments at M.I.T. have also included electromagnetic theory and antennas, microwave accelerators, and electronic and feedback circuit theory.

S. J. Mason

S. A. Goldblith

Underwood-Prescott Professor

Samuel A. Goldblith, '40, Deputy Head of the Department of Nutrition and Food Science, has been named to the new Underwood-Prescott Professorship of Food Science.

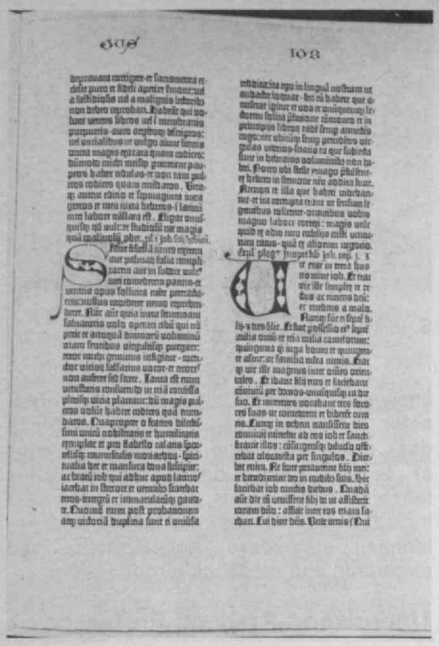
The chair honors two pioneers in the study of food preservation, William Lyman Underwood, grandson of the William Underwood who founded in 1821 what is now the nation's oldest canning firm, and Samuel C. Prescott ('94), M.I.T.'s first Dean of Science, whose collaborative research at the Institute did much to advance the canning industry at the turn of the century. A substantial part of the $600,000 to fund the chair was contributed by the William Underwood Co., and other contributions have come from companies and individuals in the food industries in response to joint efforts of the Underwood Co., M.I.T., and a national sponsoring committee.

It is the first endowed chair in a department of food science in the U.S., President Jerome B. Wiesner told a meeting of the National Canners Association in Boston this spring, where the appointment was announced. At the same meeting, George C. Seybolt, President of the Underwood Co., said the professorship "repays, in some measure, the debt that we all owe, both to the two men for whom the chair is named, and to M.I.T. for laying the scientific foundation upon which our industry stands."

Professor Goldblith, who studied under Professor Prescott as an M.I.T. undergraduate, has been a member of the M.I.T. staff since receiving his Ph.D. in the then Department of Food Technology in 1949; he became Professor of Food Science in 1961 and Deputy Head of the Department of Nutrition and Food Science in 1967, and he is widely known for scientific contributions on food technology and nutrition.

Summer Research Grants

Some 75 M.I.T. students have solved their summer job problems with the help of the National Science Foundation. They are conducting summer research



"I would like to give you this page from the Gutenberg Bible," said a rare book dealer to M.I.T.'s Librarian this spring. He turned out to be the agent of Edward H. Davis, '01.

projects, many of which they planned themselves, under five N.S.F. grants totalling almost $100,000.

One group of 15 students, headed by Neil B. Cohen, '74, is studying law as a tool for social change (*see* Technology Review *for June, p. 80*). Supported by a grant under the N.S.F.'s Student-Originated Studies Program, they are interns in the Massachusetts Law Reform Institute.

Another group, supported by a grant under the same program, is busy analyzing physical and chemical flow composition data from local rivers in an attempt to build a general model of river systems. The nine students working with Robert W. Collier, '74, in this group are studying several New England rivers originating in more-or-less primitive areas and flowing through rural and industrial locations before reaching the sea.

Three other grants, provided under the N.S.F.'s Undergraduate Research Participation Program, are supporting 85 summer research apprenticeships for students. The grants are for research in chemistry and biology, conducted under Professors Frederick D. Greene II, Charles L. Cooney, and Harvey F. Lodish. Under the terms of the U.R.P. program, no more than 60 per cent of the participants could be M.I.T. students; the others were chosen from other—principally local—universities.

A Gutenberg Leaf for M.I.T.

The rare book collection of M.I.T.'s Hayden Library has been enriched by a page from the famous Gutenberg Bible, the result of a gift to M.I.T. from Edward H. Davis, '01.

The Gutenberg leaf, from Job, is bound with an introduction which describes how an incomplete copy of the book, printed in Mainz in 1450-55, was broken up in the 1920s and its leaves sold separately. Some of the leaves, including the one given to M.I.T., had been vandalized: the illuminated initials were cut out for use in other manuscripts. The leaf from Mr. Davis has been carefully restored, however, and only close examination reveals the repair.

The leaf from Job joins another leaf, from II Kings, in Hayden Library; the latter was the gift in 1922 of William Emerson, former Dean of the School of Architecture.

Housing Costs by the Numbers

After elaborate calculations using a formula for dormitories considering such variables as dining facility location, area per resident, quality of surroundings, and other costs, a student-administration team has determined housing and dining rates for next year. These rates will average some 5 to 10 per cent higher than this year.

Approximately 25 per cent of the residents in McCormick Hall have contracted for "commons" meals this spring, and since it is not possible economically to operate the facility for that few people, that dining room will be closed next year. The number of residents in McCormick Hall will be increased by 20 next year, so that—under criteria used by the student-administration team—rents there can be maintained near present levels.

The dormitories were grouped on the basis of facility age, area per resident, and "quality of surroundings." This resulted in four categories: Senior House; Ashdown House, Baker House, and East Campus; MacGregor House; Burton-Conner, and McCormick Hall. Rent, including dining hall fees, will range from $645 to $788 for those residents not contracting commons meals and from $1,305 to $1,444 for those electing to contract commons. The commons contract will remain at $660 per year.

Next year's rents would have been higher except for cost reductions considered by the student-administration team: McCormick Hall's "free" linen service will be discontinued; the rates for Institute guests using the houses during the summer will be increased; elevator maintenance contracts have been rewritten to save $5,000; and the hours of desk service will be evaluated by each house. These changes—and others—will result in some $10,000 in savings next year; but these are offset by the large increases in utility rates (heat and electricity), a higher consumption of utilities in two new houses, and an unusually large increase in physical plant costs.

A Rare Gift of Rare Books

The rare book collection of I. Austin Kelly, III, '26, has been given to the M.I.T. Libraries, and its donor has been named Curator of Rare Books at the Institute.

The gift was announced at a reception on May 31 to honor William N. Locke upon his retirement as Director of Libraries, and Mr. Kelly said it was made "in the name of Bill Locke."

"As a collector," said Mr. Kelly of his interest in rare books, "I set two standards for the books I wanted. First, they must be in absolutely pristine condition. And second, I wanted to collect books that had an important intellectual effect, books that have had an impact on our culture and our way of life."

I. Austin Kelly, III, '26, wrote William N. Locke, Director of Libraries, a letter this spring accepting the post of Curator of Rare Books at M.I.T., but "you didn't say you were coming this afternoon," said Professor Locke (left) at his retirement party.

Then Mr. Kelly, who has been a generous benefactor of the M.I.T. Libraries for a number of years, went on to describe his interest in a number of the books coming to the Libraries, and he recorded some anecdotes of their acquisition. Among them are an illuminated Book of Hours; a copy of Hakluyt's *Voyages*; a page printed by Caxton, the first printer of the English language; John Eliot's *Indian Bible;* a first edition of Thomas Paine's *Common Sense*; *The Journal of Major George Washington,* printed in Williamsburg, Va., in 1754; and *The Letters of Junius,* which came from George Washington's library and carries his bookplate.

Acknowledging the gifts, Professor Locke, "scarcely able" to express his gratitude, said "it is truly important for M.I.T. to have these monuments of human thought."

Pass/Fail: The Hidden Grades

The faculty has dealt with the system of "hidden grades" it discovered last winter (*see* Technology Review *for March/April, pp. 75-76)* by legitimizing it. It did so (by a vote of 73 to 26) at the recommendation of a special study committee it had appointed, and over the strenuous objections of some professors.

The problem, the study committee found, is a real one. A student who applies to medical schools, where the competition for admission is intense, and whose transcript shows only grades of "pass" for his freshman work, is at a disadvantage. Most medical schools, the committee found, "assign a grade either

of B or more frequently a C to a 'Pass' grade. Since the minimum acceptable grade average for admission is about 4.3, this substitution may hurt some applicants from M.I.T. They may be further hurt by the fact that some medical schools pay particular attention to specifically required basic science courses which many M.I.T. students take as freshmen."

This year some of the 100 seniors applying to medical schools were able to have their instructors provide the grades they would have received had they not been on pass/fail. The committee recommended institutionalizing this system: a brief "meaningful evaluation" should be written for every freshman for every subject and preserved for five years by the department teaching the subject. The evaluations might include grades, and they should be released upon the student's request.

The study committee acknowledged but did not accept the finding of the Committee on Evaluation of Freshman Performance that "transmission of unofficial grades to anyone for any purpose is contrary to the intention and spirit of the pass/fail system."

Jerome Y. Lettvin, Professor of Communications Physiology, objected, saying one of the purposes of pass/fail is to "encourage adventurousness in the first year. You abandon that if you then turn around and tell the student he may regret that adventurousness later." He proposed as an alternative that, at the option of a student, a grade of pass be replaced on the transcript with an A.

Another professor expressed anger at the medical schools' "arbitrary and almost Neanderthal" admissions procedures. "Are we going to play along because the medical schools have this crazy system," he asked, "or are we going to do something that will help our students?"

Pass/No-Record Fails

The faculty this spring rejected the recommendation of the Committee on Evaluation of Freshman Performance that a system of "pass/no-record" for freshmen be given a two-year trial (*see* Technology Review *for March/April, pp. 75-76*).

Under the present pass/fail system, a freshman is given either a "pass" or an F; under "pass/no-record," either he would be given a "pass" or his record would carry no indication that he had ever enrolled in the subject.

Proponents of the new system felt that it was "the logical extension" of pass/fail because it would allow a student "to enter the sophomore year with a clean record." Furthermore, professors might raise their standards if they knew that failing a student would not penalize him.

And there would be a built-in penalty for failing a required subject: the next time around, the student would be a sophomore and have to take it for a regular letter grade.

Opponents feared that the system would be "an open invitation to mediocrity," encouraging students to take large overloads in the freshman year and do only marginal quality work in each subject.

It would be bad education, went another objection, "to provide a reward for achievement, however mediocre, but provide no punishment for failure." And it would be unethical for the registrar to "conceal a student's least satisfactory work" when providing transcripts.

There were also several objections on administrative grounds. How, for example, does one certify that a student is carrying a full course load? And would the system not abolish the end-of-term visits to a student's advisor that are necessary in order to drop subjects?

As a member of the Physical Plant staff for over 40 years, John L. Ayer took many opportunities to help M.I.T. oarsmen; this spring, as he retired, he christened a shell named in his honor. Mrs. Katharine McCurdy has been wedded to crew even longer—the McCurdys celebrated their 50th wedding anniversary just after she and Horace W. McCurdy, '22, attended Mr. McCurdy's 50th reunion in June.

"The Ayer" and "The Kate"

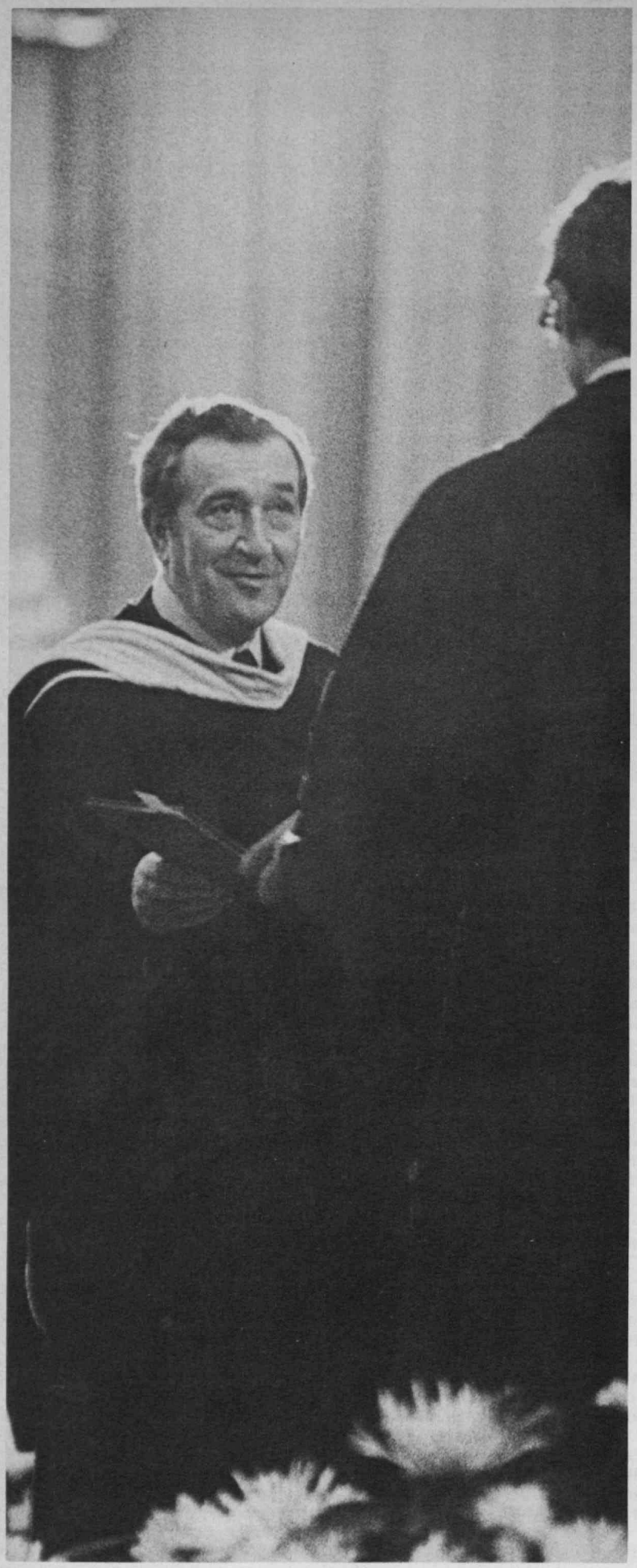
Two new eight-oared shells joined the fleet at the Pierce Boathouse this spring, and both bear names with special meaning to crew at M.I.T.

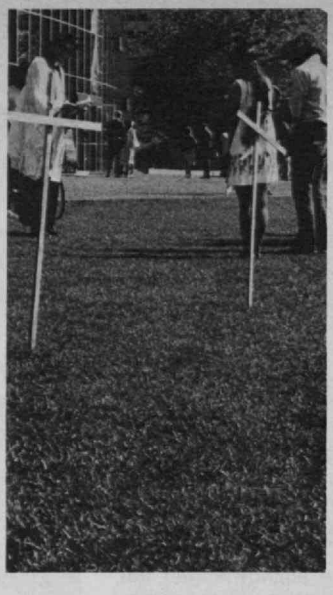
One, the *John L. Ayer,* honors the Institute's long-time Foreman of Grounds, who was praised at christening ceremonies by Ross H. Smith, Director of Athletics, for his "abiding interest in the crew and his help in developing first-class facilities for Institute oarsmen."

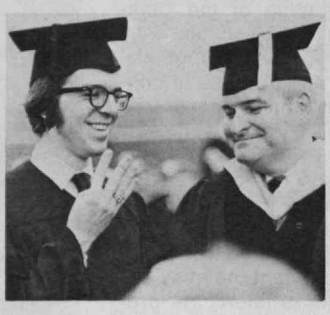
The other, officially the *Katharine McCurdy* but unofficially *The Kate,* bears the name of the wife of Horace W. McCurdy, '22, who was himself a member of M.I.T.'s first intercollegiate crew and since then has been an ardent supporter of the sport and of the M.I.T. athletic program. Indeed, said James R. Killian, Jr., '26, Honorary Chairman of the Corporation, Mr. McCurdy has been a "successful part of every M.I.T. crew season for 50 years."

At christening ceremonies on May 25, Philip A. Stoddard, '40, Vice President for Operations of M.I.T., pointed out that the *Ayer* was the first major piece of Institute property to carry the name of a Physical Plant employee. Mr. Ayer, severely crippled by a stroke early this year, performed the act of christening.

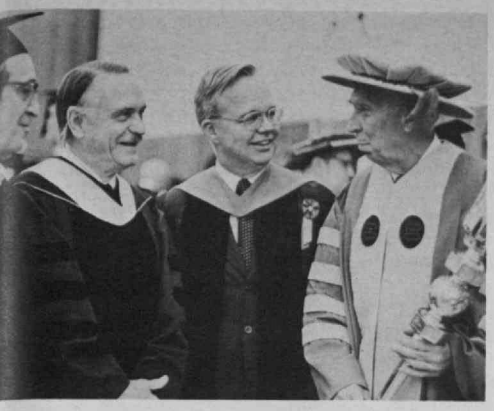
The *Katharine McCurdy* was christened by Mrs. McCurdy on Sunday, June 4, before more than a 100 members of Mr. McCurdy's Class of 1922 assembled on the campus for their 50th reunion. It turned out also to be Mr. and Mrs. McCurdy's 50th wedding anniversary, and this made especially joyful Dr. Killian's task of greeting them as "warm and generous friends of this institution." Mrs. McCurdy is one of three ladies for whom M.I.T. shells are named—the other two are Mrs. Killian and Mrs. Julius A. Stratton, wife of the Institute's eleventh President. "It's a great honor," and she was "overwhelmed by the number and distinction of the guests" at her christening, Mrs. McCurdy said.

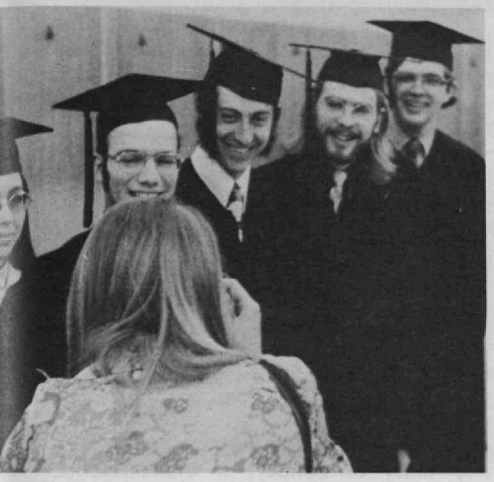






Highlights and lowlights of Commencement 1972: Rev. John Crocker leads a prayer for peace among the crosses on Kresge lawn . . . That's Douglas D. O'Shaughnessy, '72, counting his four degrees for Chancellor Paul E. Gray, '54 . . . and Dr. and Mrs. Michael J. Marcus ('68, '68) after both received Sc. D. degrees . . . A buss for the President of 1972 (Sandra G. Wiener) from the President of 1922 (Parke D. Appel) . . . A red antiwar armband for Michael D. Feirtag from Bruce S. Schwartz . . . Donald F. Carpenter, '22, and President Jerome B. Wiesner at the Commencement Luncheon . . . the Guests of Honor (left to right, top opposite): President Wiesner, Luis A. Ferre, '24, Governor of Puerto Rico; Howard W. Johnson, Chairman of the Corporation; and Paul V. Keyser, Jr., '29, President of the Alumni Association . . . Officers of the Class of 1972 line up in the press room . . . the discordant note, when Anthony Kroch, '72, removed his robe and handed a subpoena to President Wiesner (Photos: Margaret Foote and Sheldon Lowenthal, '74)





Commencement: Fair Weather and an Uneventful Celebration

Just as the turbulence of a few weeks in May (*see* Technology Review *for June, pp. 74-76*) failed to distract M.I.T. from the normal progress of the academic year, so a minor distraction failed to dampen the warmth and cheer of the Institute's 106th Commencement on June 2.

The stately ceremony with overtones of medieval tradition proceeded almost without event; even the weather was favorable. The Institute awarded 1,459 degrees to 1,272 graduates; more than 4,500, including graduates, parents, relatives, and friends of graduates, filled Rockwell Cage for the ceremony.

In his first commencement address as President, Jerome B. Wiesner began by acknowledging the graduates' "distress about the society into which you are emerging." He said that although technology appears to be responsible for many of our problems, the solution will require "new technology—sensitively relevant technology—conceived and developed by a new generation of applied scientists and engineers." He encouraged those uneasy about their search for satisfying careers: "There are as many constructive, creative, and important opportunities in science and technology as you will find in any field if you only will be optimistic enough to try them."

A few more than 100 of the graduates wore red armbands to symbolize their feelings of protest against "the war in Indochina, war research at M.I.T., or anything else you're——off about," as the call for "Graduating Students—Unite!" put it. Two tried unsuccessfully to make political speeches when they were given their diplomas, and four doffed their robes before ascending the stage to "dramatize" their protest. One of those who tried to speak, S.D.S. member Anthony Kroch, gave Dr. Wiesner a subpoena to appear at the trespass trial of the students who had occupied the R.O.T.C. offices in May. The disruption lasted only a few seconds and many people in the room were not aware of what was happening.

Another graduate wearing a red armband caused a slightly different disruption. Rebecca A. Donnellan, receiving an S.B. in management, took her diploma from Dr. Wiesner and then embraced and kissed him.

Rabbi Herman Pollack, who retires this year after 20 years as Director of the B'nai Brith Hillel Foundation at M.I.T., gave the invocation—himself wearing the red armband. Former President Howard W. Johnson, now Chairman of the Corporation, was in the new (to him) role of presiding officer at the Exercises. He was joined among the guests of honor by James R. Killian, Jr., '26, Honorary Chairman of the Corporation; Luis A. Ferre, '24, Governor of Puerto Rico; Mrs. Barbara Ackermann, Mayor of Cambridge; Paul E. Gray, '54, Chancellor; and Dr. Wiesner. Paul V. Keyser, Jr., '29, President of the Alumni Association, was Chief Marshall.

For the first time in M.I.T. history, a member of the Corporation was awarded a degree. Christina Huk Jansen, '63, actually received her Doctor of Science degree in metallurgy last September, a month before she began a three-year term on the M.I.T. Corporation in the category of Representatives from Recent Classes. But she joined the June graduates to receive her hood.

Sandra G. Wiener, President of the Class of 1972, received not only the S.B. degree in life sciences but also the S.M. in nutrition and food science. She was one of 49 young women—a record number—who graduated this year.

Douglas D. O'Shaughnessy set what is believed to be the M.I.T. record for most degrees at the same time. He received two S.B.'s, (in electrical engineering and mathematics), the S.M. in electrical engineering, and the E.E.

More than 100 representatives from the Class of 1922 joined the academic procession. Led by class president Parke D. Appel, they made up the largest 50-year representation ever to return for Commencement at M.I.T.

Among 650 graduate students receiving advanced degrees on June 2 were six completing work under a cooperative program in oceanography between M.I.T. and the Woods Hole Oceanographic Institution; Paul M. Fye, President of W.H.O.I., joined Dr. Wiesner in presenting these degrees.

The Makers of the Future

Changes at M.I.T. and in the nation have made the last four years "singular in the Institute's history," Paul E. Gray, '54, Chancellor, told members of the Class of 1972 in a convocation address on June 1. Taken together, he said, these changes stress the increasing importance of understanding "the necessary and proper role of science and technology as the servants of society and mankind."

Among Dr. Gray's examples of change:

☐ A "remarkable expansion in the scope and nature of educational programs" at M.I.T., as a result of which freshmen now enroll in nearly 200 different subjects and the lecture-recitation mode of teaching is no longer the principal form of educational encounter.

☐ Growing numbers of women at M.I.T. "More women will receive degrees from the Institute during the next 10 years than in the entire first century of co-education at the Institute," Dr. Gray said.

☐ New departments, courses, and laboratories established to recognize the growing breadth of M.I.T.'s interests and of technology's reach—ocean engineering, urban studies, philosophy, policy alternatives, for example.

☐ The advent of "pass/fail" grading, "adopted in an effort to ease the transition to this quite competitive academic environment. You demonstrated," Dr. Gray told the Class, "that the prod of grades was indeed superfluous by working as hard as your predecessors but, I believe, worrying about your performance somewhat less."

☐ The worsening economic environment for higher education and technology. Federal support for research and graduate education "turned into a pattern of fixed support which did not keep up with

the pressures of inflation," Dr. Gray said, and he warned that the country's recent recession, with "unprecedented impact on the scientific and engineering professions, . . . will continue to influence your lives, and mine, for some time to come."

Dr. Gray admitted that the Class of 1972's years at M.I.T. have coincided with "a season for rampant, often mindless, criticism of technology." Yet, he said, "there is no way in which this nation or the world can have a viable future without the wise and humane application of technology.

"What is required is not less, but better, more informed technology, which reflects real social and human needs and which benefits from full consideration of alternatives, impacts, and costs as well as benefits.

"You will be the makers of that future," Dr. Gray told the Class.

1922 and the Tradition of Excellence

Donald F. Carpenter, '22, speaking for the 50-year Class of 1922 during the 1972 Commencement Luncheon on June 2, said he would give no advice to the members of the fledgling Class of 1972; two reasons: they don't want it, and they'd forget it anyway.

But then he proceeded to break his promise:

"Do your homework," he said. "Check and recheck your program. And when you're right, go ahead and don't let anybody stop you."

And remember, Mr. Carpenter told the Class of 1972 and their parents, that 50 years ago "we were not old fogies," either.

Mr. Carpenter also had some friendly advice for President Jerome B. Wiesner: "Look around at these fellows," he said, pointing to the section of the luncheon audience decorated with red coats and berets, "and see how vigorous they are." He called attention to the "importance of their long perspective," and he said of his classmates, "Their record is a mighty and marvelous thing."

Dr. Wiesner agreed. "The Class of 1922," he told the luncheon audience, "has contributed a remarkable example to the M.I.T. tradition of excellence."

For "Superbly Effective" Teaching

Samuel I. Cohen, '68, who has been a teaching assistant in the M.I.T. Physics Department since receiving his S.B. degree in physics from M.I.T., was awarded M.I.T.'s Goodwin Medal for conspicuously effective teaching during the 1972 Commencement Luncheon.

Irwin W. Sizer, Dean of the Graduate School, reported to the Luncheon audience some of the endorsements received for Mr. Cohen from faculty, students, and coworkers: ". . . his service to the Department in every aspect of teaching has been selfless—and superbly effective . . ." ". . . virtually singlehandedly coaxing and nurturing the Physics Department's participation in the Undergraduate Research Opportunities Program . . ." ". . . seed and catalyze an atmosphere of faculty openness and accessibility to students . . ." ". . . general consultant to whoever is around . . ." ". . . has had more personal influence on my educational goals than any other teacher . . ." ". . . playful, even puckish . . ."

Mr. Cohen came to M.I.T. from South Fallsburg, N.Y., and he expects to receive his doctorate at the end of the current summer; his thesis is in the field of atomic beam research. The Goodwin Medal was established by his family in memory of the late Harry Manley Goodwin ('90), the first Dean of the M.I.T. Graduate School, to honor graduate students for teaching.

Advice to New Officers: Empathy Between Leader and Led

Brigadier General Charles D. Daniel wanted the 35 students who received commissions in M.I.T.'s Reserve Officers' Training Corps programs on June 2 to remember one thing about leadership: What will make you a good leader is empathy—the ability to feel what the men under you are feeling. We can learn, he said, from the Viet Cong, the Chinese Communists, and the Red Army of North Korea, for in each army we find a close relationship between the leaders and the led. This is necessary in part because these armies, lack our advanced communications technology; but we must never accept any excuse that permits a leader to slip from daily contact with his men.

General Daniel, who is the Army's Director of Research, said that the Army is increasing its support of the social sciences—"we have paid too little attention to the characteristics of our junior officers and enlisted men." And though he proposes a continuing place for Army-supported research in the universities, he sees limits to technology: "The critical paths of today's decision-making pass through some quite sophisticated machines—but the paths always intersect at a leader."

Seventeen members of the M.I.T. Class of 1972 received (or will receive) commissions in the U.S. Army and Army Reserve, two received Navy commissions, and 14 were commissioned in the U.S. Air Force.

Nostalgia, the Boston Pops, And the Limits to Growth

Having attended five receptions, three luncheons, three dinners, two breakfasts, and one concert in four days, President Jerome B. Wiesner understandably called the period from June 2 to 5 "Alumni Physical Fitness Weekend." It was his first experience with Commencement and Alumni Day as President of the Institute, and no one could doubt that he emerged from the weekend with a deep need for rest as well as an overwhelming sense of the pride and devotion which brought more than 2,500 alumni and their guests back to *alma mater.*

The Class of 1922 assembled for its 50th reunion in greater numbers than any previous 50-year-class—103 of its members marched as honored guests in the processional at the Graduation Exercises. Their reunion continued in McCormick Hall on Saturday and Sunday, with a clambake shore dinner at Wentworth-by-the-Sea, N.H., on Saturday noon being the special feature.

On-campus reunions proceeded also for the Classes of 1912 (McCormick Hall), 1932 (MacGregor House), 1947 (MacGregor House), 1962 (MacGregor House), and 1967; highlights included the 1967 clambake on Briggs Field on Saturday afternoon, 1962's Saturday at Sturbridge Village, 1932's Boston tour (with luncheon at the Aquarium Restaurant) on Sunday, and 1947's Sunday afternoon cruising Boston Harbor.

Nostalgia was flowing even more plentifully by Sunday evening when Arthur Fiedler emerged in the red coat of the Class of 1922 to conduct members of the Boston Pops Orchestra in M.I.T. Night at the Pops at Symphony Hall. It was a sell-out crowd of some 2,300 members of the greater Institute community and their guests. John L. Buttrick, Assistant Professor of Music at M.I.T., was soloist in Schumann's *Piano Concerto in A Minor,* and the concert was further enlivened when Parke D. Appel, President of the Class of 1922, made official Mr. Fiedler's Honorary Membership in that Class by handing him the red beret of the class reunion as the second intermission ended.

After perfect weather Friday, Saturday, and most of Sunday, a thunderstorm dropped heavy rain and hail on eastern Massachusetts Sunday evening, and umbrellas, newspapers, plastic sheets, and even trays were in order between the Student Center and buses to Symphony Hall that evening. Better weather was back by Monday noon, and the rain failed to reduce attendance below record levels at all Alumni Day events on Monday.

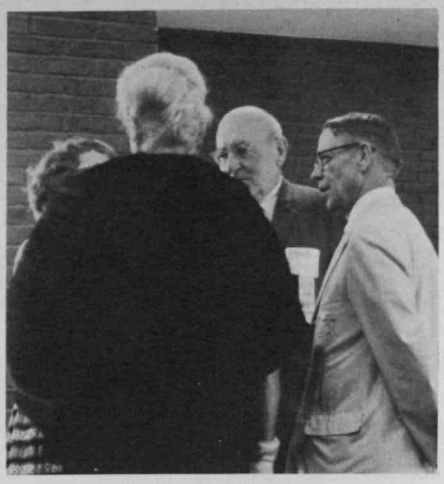
Indeed, Kresge Auditorium was filled by 9:30 Monday morning when Colonel David R. Scott, S.M.'62, began his report on Apollo 15's "Voyage to the Moon . . . and Beyond," the first installment of the day's symposium on "Moving Toward the Year 2000."

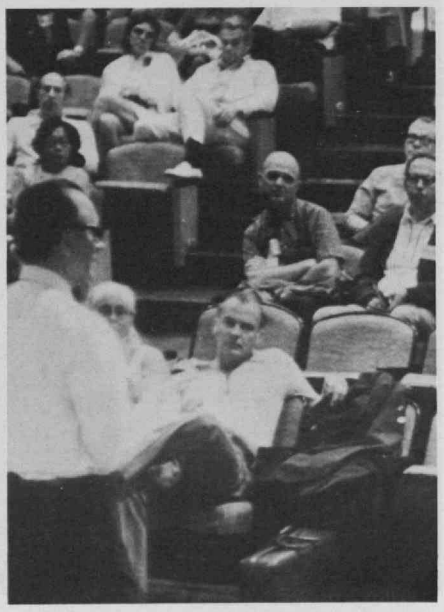
Everyone in his audience was impressed by Colonel Scott's knowledge of the lunar geology as well as of the Apollo program, and none could doubt his enthusiasm for future space exploration: "Space is the best and possibly the only arena in which the U.S. can simultaneously demonstrate its peaceful intentions, its openness of discussion, and the strength of its science and technology. . . . The moon has shifted the tides once again, and we stand at the dawn of the greatest age of exploration in the record of mankind. . . . Whether or not man is alone in the universe is a supreme question."

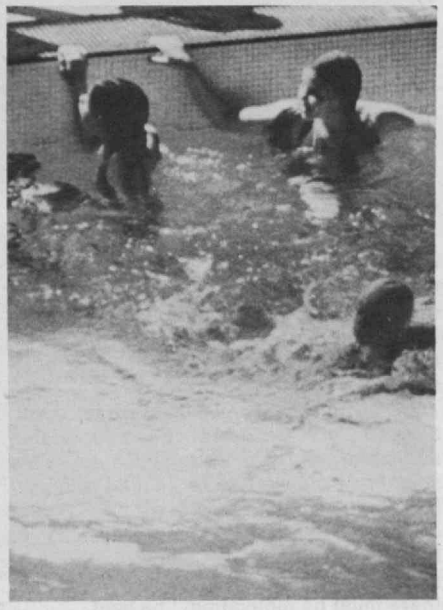
Then came Secor D. Browne, Chairman of the Civil Aeronautics Board, who matched in his enthusiasm for commercial aviation and air transport that demonstrated by Colonel Scott for space exploration.

After lunch there were four more contributors to the symposium:

☐ Philip Morrison, Professor of Physics, on "The Nature of the Universe:" Like







Back to Cambridge in the spring: the Class of 1912 reunion at Endicott House . . . Dean Alfred A. H. Keil of the School of Engineering with the Class of 1947 . . . Greeting old friends in 1932 . . . President Jerome B. Wiesner with 1962 . . . and fun even for the kids!

an onion, we can peel back layers of history in our earth, our solar system, our galaxy, and our universe. Though the 5 billion years which is the age of the Earth seems very long, the stuff of which it and we are composed must be far older, for none of the processes which we can imagine to have taken place on Earth could have created the atoms and elements which are familiar to us here. Such dense nuclear particles as protons and neutrons must be attributed to a still earlier era—a phase previous to that of the universe as we can even imagine it. And if this seems a complex issue for our solar system, consider that the Milky Way—only our galaxy, one of hundreds we know to exist—contains 100 stars like our sun for every man, woman, and child on Earth.

☐ Jay W. Forrester, S.M.'45, Professor of Management, on "A World Model:" Model-based systems analysis suggests that we face a turning point in world growth. Heretofore it has been possible for man to enhance the present at the expense of the future—to occupy space on the globe and to consume its resources with little concern for how future generations might view his pillage. But in a society approaching limits, postponing into the future the payment for the present does not work. Thus an analysis of this kind suggests that there is, in fact, a limit to growth.

☐ Robert W. Mann, '50, Germeshausen Professor, on "Technology of Medicine:" We have failed for years to recognize that nature is unresponsive to our ways of parochializing it; an example is found in our compartmentalization of medicine and engineering. Less than 1 per cent of the cost of operating the U.S. health care system has any obvious relationship to engineering competence; compare this with the engineering input to any other major social effort such as transportation energy, or manufacturing. As we seek to improve our health care system, we must ask if a substantially larger investment in technology can be useful, and if so how. And it is this question which is at the center of M.I.T.'s new efforts in bioengineering.

☐ Paul A. Samuelson, Professor of Economics, on "Change in Society:" If in fact there is a "greening" of society, then there must also be a "bluing;" and the result may well be a kind of turquoise—an admixture of the new culture with the old.

The symposium was interrupted at midday for the annual Alumni Day Luncheon, for which a sell-out became nearly a minor disaster. Advance reservations indicated attendance of less than 1,100; the M.I.T. Dining Service, just to be sure, prepared 1,202 luncheons; but in the end 1,208 tickets were sold and six alumni (and/or their guests) found themselves eating left-overs from Sunday night—just the way it sometimes is at home.

By the end of the afternoon, everyone was ready for relaxation and more nostalgia: "That used to be mud . . . Yes, I remember our freshman year . . ."

How To Be Part of the Answer as Well as Part of the Problem

Relevance has a double meaning for the modern university, President Jerome B. Weisner told M.I.T. alumni in his report at the annual Alumni Day luncheon: students want to study the problems of the nation and the world; and the university suddenly finds that it is as much part of the problems as of their solutions.

"In a very real sense we have all the problems of the modern world in a microcosm," Dr. Wiesner told the alumni, citing as examples the underrepresentation of women and racial minorities on the faculty and staff, M.I.T.'s extra efforts—and expense—to reduce its atmospheric pollution, and its need for help from the community to maintain peace and order on its campus.

But so, too, said Dr. Wiesner, is M.I.T. at the center of debate and study on how to resolve many modern social issues—and indeed this role is the "most dynamic" aspect of the Institute's many programs of teaching and research.

Whenever we attempt to work on problems with clear social relevance, he said, we discover that we must bring together people with many different skills (and it is fortunate, he said with a smile, that "our students don't realize how difficult it is to organize interdisciplinary activities").

It is in response to these needs—and to the better preparation which M.I.T. undergraduates bring to the Institute each year—that the substance of an M.I.T. education is changing. Dr. Wiesner cited new interdisciplinary programs in such fields as environmental pollution, energy resources, ocean engineering—even education itself—through which the faculty and students discover and assess the importance to society of many technological developments.

Toward Policy Alternatives

Alfred A. H. Keil, Dean of the School of Engineering, added details; for example, he said, studies of transportation, water resources, and health care in engineering departments must cover not only the technology involved; they must also comprehend the economic, legal, governmental, and social constraints which affect the solutions an engineer can propose.

Hence the importance, said Dean Keil, of understanding alternatives—and of M.I.T.'s "determination to combine practical engineering solutions with teaching and research in engineering science and policy alternatives."

Community Values in Design

A similar emphasis came from William L. Porter, who was named Dean of the School of Architecture and Planning late last year. The concern of that School is broadly "for the quality of the human experience," he said. To contribute effectively at that level, architects must understand not only the aesthetics and engineering of their work; they must as well be able "to contribute to community values and to reform them."

These are the ways "we are changing the School," Dean Porter said:

☐ Improving the ability of students to conceptualize solutions—"enhancement of the projective imagination," Dean Porter called it. "Society cannot afford the social or financial costs of experimentation."

☐ Achieving new links between education and professional practice, to help students "obtain knowledge of and feeling for the workings of complex social institutions, for individual and group motivations, and for types and spreads of life styles."

☐ Strengthening existing programs in urban economics, the history, theory and criticism of art, architecture and urban form, and housing in developing areas; and adding new programs in health planning and management in architecture and urban planning.

☐ Adding new courses and short courses to meet more specific new needs—for example, computer languages oriented to architecture and planning and how to obtain government funding for urban projects.

Restoring the Sense of Community

Dr. Carola Eisenberg, who became Dean for Student Affairs on July 1, also spoke on a similar theme. M.I.T. students, she said are "extraordinarily bright and compassionate. But the community is fractured; somewhere we have failed." As she assumes her new duties, Dr. Eisenberg said, she recognizes "that some issues go far beyond M.I.T.," that these can be best approached through "an effort to emphasize our common humanity—to transmit problems, not solutions." She would thus, said Dr. Eisenberg, "attempt to restore to M.I.T. the sense of community.

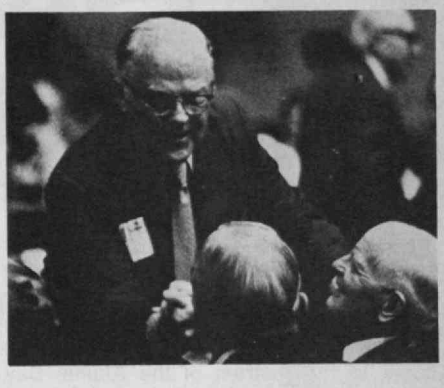
"The Trouble Is, Professor . . ."

If M.I.T.'s School of Engineering has moved too far toward engineering science and away from engineering practice in the past two decades, Alfred A. H. Keil, its Dean, means to move it back again.

"Up to now we have 'missed the boat' because we have not been providing sufficiently early a perspective to relate scientific knowledge to human affairs," Dean Keil told members of the 25-year Class of 1947 at a "rap" session in Kresge Auditorium on June 3. "Education is more than a transfer of knowledge; there must be motivation," he said.

But engineering and its responsibilities are changing, too; Dean Keil emphasized for his audience the need for engineering students to be aware of the consequences of their work, as well as of the technical and economic aspects which must control it. "If you fail to understand the impact of technology on society, you cannot be an effective professional in engineering," he insisted. You have to understand the whole system which technology creates as well as the context in which it operates.

But will that socially conscious engineer be able to resolve our problems by doing work instead of arguing about it, Dean Keil was asked by a Class of 1947 graduate who found himself impatient of the arguments about environmental and



Editorial columns can suggest the substance of the program for Alumni Day 1972, but photographs tell the human side—meeting old friends . . . exploring the campus . . . talking with M.I.T.'s new administrative team . . . generous wining and dining. A highlight was the gift of the red coat and beret of the Class of 1922 to Arthur Fiedler during his M.I.T. Night at the Pops concert (opposite page); Parke D. Appel, President of the Class, thus made Mr. Fiedler its most distinguished honorary member. (Photos: Sheldon Lowenthal, 74)

M.I.T. students first began flying gliders in the fall of 1909. This model, built by one of the members of the Aero Club, is in flight that year at a local country club. (Photo reprinted from Technology Review *for January, 1910.) The M.I.T. Soaring Association recalls that early work in announcing a Symposium on Motorless Flight, scheduled for next October.*

social issues which surround the construction of new electric generating facilities these days. "We can't take ten years to solve these problems; but you are proposing," Dean Keil was told, "an entirely new way of solving problems which will extend rather than shorten the decision process."

Dean Keil responded with a brief statement of educational philosophy: "At the heart of engineering education is something that in other days was called the 'design process'," he said—"a matter of learning how to conceptualize. This is the real issue when it comes to understanding system analysis—conceptualization."

Shattering Precedents—With over $4 Million

When Paul V. Keyser, Jr. '29, presiding as President of the Alumni Association, came to the rostrum of the Alumni Day luncheon on June 5, he knew he had one record to announce—but he hardly expected to preside over announcements of four more.

Mr. Keyser's record was the report of the 1972 Alumni Fund: 18,200 donors by June 2, with total gifts of $2,283,000. Both represent new highs for the Alumni Fund for the seventh consecutive year—the only alumni fund in the country with such a continuing record of growth, Mr. Keyser said, and all the more significant because 1972 was "a year of some adversity, especially in the early stages."

Four other record-breaking reports quickly followed from four reunion classes, the total of reunion gifts in their reports coming to just over $2 million.

Richard S. Mooney, Reunion Gift Chairman for the Class of 1947, reported a record 25-year gift of $728,593 from 439 members—including 56 "beavers," 5 "leader beavers," and 6 "eager beavers." Some of the money, he said, is earmarked for a special fund to be used by the Dean for Student Affairs "to increase the quality of life in the Institute houses."

Next came Thomas E. Sears, Jr., speaking for Robert B. Semple, Reunion Gift Chairman of the Class of 1932. He began with an apology: "Remember that 1932 was a year of 'insurmountable opportunity' to start out from M.I.T." But no apology was needed: the 40-year gift was $363,000 from 318 members of the Class.

Parke D. Appel, President of the Class of 1922, said that his presentation was "one of my really happy moments." Not including the reunion gift, he said, members of the Class had already given M.I.T. $1,870,000—including Class of 1922 Professorship Fund, which at the time of its establishment was the largest endowment for a professorship in any U.S. university. Now the Class has embarked on a "Career Development Fund," said Donald F. Carpenter, Reunion Gifts Chairman, to help "promising young faculty members" who are "devoted to excellence in teaching" and "whose loyalty to the U.S. is unquestioned;" of the Class' reunion gift, $330,000 has been designated for this Fund, and additional contributions to it are expected. It remained for Dale D. Spoor, Class Agent, to report the 50-year gift: 337 members of the Class—60 per cent—contributed to a total of $909,000. (In addition to this total, Mr. Carpenter, who is also Class Estate Secretary, reported that $685,000 has been pledged to M.I.T. in bequests by 28 members of the Class.)

Finally, John A. Lunn announced a precedent-setting two-part 55-year gift from the Class of 1917: a $100,000 endowment fund, and a payment of $80,700 toward a $100,000 scholarship fund in aeronautics and astronautics to honor Edwin E. Aldrin, Jr., Sc.D.'63, the astronaut. (Mr. Aldrin's father is a member of the Class of 1917, of which Mr. Lunn is President.)

When it was all over, President Jerome B. Wiesner arose to express his thanks to those who had made possible the record gifts—and to all alumni: "I thank you personally for the enormous feeling of support I have had in my first year in the Presidency of M.I.T.," he said to a standing ovation of over 1,200 in Rockwell Cage.

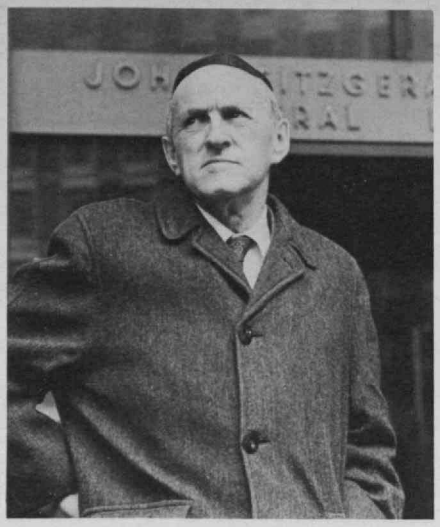
Reviving an Old Interest

The technology of motorless flight—an old topic of interest at M.I.T.—will have a new celebration when the M.I.T. Soaring Association sponsors a three-day symposium covering aerodynamics, design concepts and structures, soaring meteorology, instrumentation, self-launching sailplanes, and performance testing next October.

The Association's announcement says the symposium "will commemorate 63 years of motorless flight activity at M.I.T." It was in 1910 that *The Tech* reported the first flight of a glider constructed by the Aero Club, of which Elisha N. Fales, '11, was President. The trial, in which the craft reached 35 ft. over the Charles River, "was more successful than any one had dared hope." Twelve years later a new glider designed by Otto C. Koppen, '24, and the late Edmund T. Allen, '23, was flown by Mr. Allen in the international soaring meet at Clermont-Ferrand, France. This was "the first time a U.S. university participated in international soaring competition," says the Soaring Association's announcement.

Though it claims descent from the Aero Club formed at M.I.T. in 1909, the Soaring Association in its present form dates only from 1969. Its 75 members operate the Association's five sailplanes—four two-seaters and one single-seater.

Just before he retired as President of M.I.T. in 1966, Julius A. Stratton, '23, posed for sculptress Beatrice Paipert, '51. When the M.I.T. Faculty Club sponsored an exhibit of Miss Paipert's work this spring, a reunion was arranged between subject and sculpture.



Less than two months before his retirement as Director of the B'nai Brith Hillel Foundation at M.I.T., Rabbi Herman Pollack was arrested in Boston while participating in anti-war demonstrations in front of the U.S. government's John F. Kennedy Building. (Photo: William Saidel, '75)

Rabbi Pollack Retires

Rabbi Herman Pollack, who 20 years ago became the first Director of the B'nai Brith Hillel Foundation at M.I.T., retired on June 30.

During his 20 years at the Institute, Rabbi Pollack guided the development of a full program of extracurricular activities dedicated to the enrichment of Jewish life and culture on the campus; he was also widely known and respected as a scholar of the Hebrew tradition, a counselor to students, and an outspoken opponent of the Indochinese war.

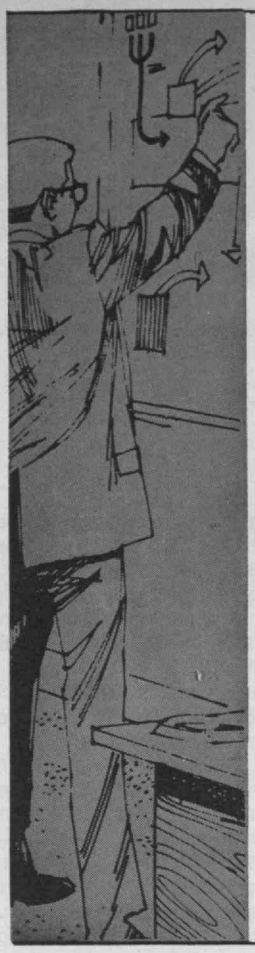
Rabbi Pollack came to the Institute from a similar post at Brooklyn College, where he was also a member of the faculty. While at M.I.T. he has taught at Tufts and Boston Universities and has served as a draft counselor for many undergraduates.

William Webster, 1900-1972

William Webster, '23, who had been a member of the M.I.T. Corporation since 1959, died on May 17 following a long illness. He was 72.

Mr. Webster was former President and Director of the New England Power Service Co. and former President of the Yankee Electric Co., and at the time of his death he was a member of the Atomic Energy Commission's General Advisory Committee.

A graduate of the U.S. Naval Academy, Mr. Webster received the S.M. degree from M.I.T. He served thereafter in the Navy until 1928 when he joined the New England Electric System in Providence as Assistant to the General Manager. He became Vice President in 1942, Executive Vice President in 1950, and President in 1959, and he was Chairman and Chief Executive from 1963 until his retirement. As President of the Yankee Electric Co.,



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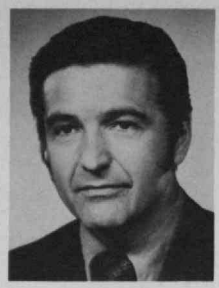

F. J. Ross, Jr.

he was responsible for construction of that Company's nuclear power station in Rowe, Mass., in 1960.

Mr. Webster became a Life Member of the M.I.T. Corporation in 1964, following five years' service as a Term Member. He was Chairman of the Corporation Visiting Committee for the Department of Nuclear Engineering at the time of his death.

Duncan R. Linsley, 1902-1972

Duncan R. Linsley, '22, Life Member Emeritus of the M.I.T. Corporation who was Director of the First Boston Corp. of New York, died in Fairfield, Conn., on April 29. He had made his career in the New York financial community since graduating from M.I.T. in business administration, first with Harris, Forbes and Co. and since 1934 with the First Boston Corp.

Mr. Linsley first joined the M.I.T. Corporation as an Alumni Term Member in 1942; he was elected to Life Membership in 1951 and became Emeritus Life Member in 1966. During over 25 years as an active member of the Corporation, Mr. Linsley served on several of its standing committees and as chairman and member of a number of Visiting Committees, including Student Affairs, Medical, Mathematics, Electrical Engineering, Management, and others. He was also active in alumni and development programs of the Institute.

Edward N. Dimond, 1921-1972

Edward N. Dimond, Manager of the Student Center, died suddenly on April 12; he was 51.

Mr. Dimond came to the Institute in 1946 to work as a mechanic in the Department of Mechanical Engineering. He was promoted to Assistant Manager of the Student Center in 1965 and to its Manager one year later.

Individuals Noteworthy

Awards and Honors: to **Myles Morgan,** '23, the British Iron Steel Institute's Bessemer Gold Medal Award . . . to **James H. Doolittle,** '24, the 1972 Tony Jannus Award . . . to **Whitworth Ferguson,** '22, the 1972 Chancellor's Medal from the State University of Buffalo . . . to **Harold Chestnut,** '39, an Honorary Degree of Doctor of Engineering, Villanova University . . . to **Edward O. Jess,** '42, the Legion of Merit, U.S. Air Force . . . to **Hatten S. Yoder, Jr.,** Ph.D.'48, the Arthur L. Day Prize and Lectureship from the National Academy of Sciences . . . **Robert W. Mann,** '50 and **Arthur K. Kerman,** Ph.D.'53, to Fellows of the American Academy of Arts and Sciences . . . **Paul E. Gray,** '54, to Board of Trustees, Boston Museum of Science . . . to **Robert E. Dickinson,** '62, the Outstanding Publication Award from the National Center for Atmospheric Research . . . to Apollo 15 crew member **David R. Scott,** S.M.'62, the Robert J. Collier Trophy of the National Aeronautic Association . . . to **Ivan E. Sutherland,** Ph.D.'63, the Vladimir K. Zworykin Award, National Academy of Engineering . . . to **John M. Wallace,** Ph.D.'66, the James B. MacElwane Award, American Geophysical Union . . . **Joseph P. Carroll,** S.M.'66, to White House Fellow . . . to **Samuel A. Cohen,** '68, the Goodwin Medal for effective teaching, M.I.T. . . . **Dewey Quin Seeto,** '68, to Woodrow Wilson Fellow . . . **Shirley A. Jackson,** '68, to Fellow, Educational Foundation of American Association of University Women . . . **Tyler B. Thompson,** '70, to Fellow of National Science Foundation . . . to **Edwin H. Land,** Visiting Institute Professor, M.I.T., the Founders Medal, National Academy of Engineering . . . to **Irvin Kaplan,** M.I.T. Professor of Nuclear Engineering, the Arthur H. Compton Award, American Nuclear Society . . . to **Gyorgy Kepes,** Director of M.I.T. Center for Advanced Visual Studies, an honorary degree from Lehigh University . . . to **Hoo-Min D. Toong,** '67; **Charles W. Lynn,** '68; **Norman D. Punsky,** '69, and **James M. Tien,** S.M.'70, M.I.T. Electrical Engineering Department Supervised Investor's Services, Inc. Awards for excellence in teaching.

University Appointments: **Felix E. Browder,** '46, to Louis Block Professor of Mathematics, University of Chicago . . . **Carl Barus,** S.M.'48, to Full Professor of Engineering, Swarthmore College . . . **Peter G. Dayton,** '50, to Full Professor, Emory University School of Medicine . . . **Gordon J. Van Wylen,** ScD.'51, to President of Hope College. . . **G. Stuart Patterson, Jr.,** '57, to Associate Professor of Engineering, Swarthmore College . . . **Edward E. Schweizer,** Ph.D.'57, to Full Professor of Chemistry, University of Delaware . . . **Donald C. Carroll,** S.M.'58, to Dean of Wharton School, University of Pennsylvania . . . **Arthur E. Humphrey,** S.M.'60, to Dean of Engineering and Applied Science, University of Pennsylvania . . . **Mack Mauldin,** S.M.'62, to Professor and Chairman, Department of Aerospace Studies, Drake University . . . **Dennis L. Meadows,** Ph.D.'69, to Associate Professor in Thayer School of Engineering and Amos Tuck School of Business Administration, Dartmouth College.

Craig P. Hazelet, '18, to Honorary Member, American Society of Civil Engineers. . . . Elected to Membership in the National Academy of Sciences: **Avram Noam Chomsky,** Ward Professor of Modern Languages and Linguistics, M.I.T.; **George B. Field,** '51; **Robert D. Luce,** '45; **Willem Van Rensselaer Malkus,** Professor of Applied Mathematics, M.I.T.; **Robert M. Solow,** Professor of Economics, M.I.T.; **Steven Weinberg,** Professor of Physics, M.I.T.; **George W. Whitehead,** Professor of Mathematics, M.I.T. . . . Elected to National Academy of Engineering: **Morris Cohen,** '33; **Thomas W. Lambe,** Sc.D.'48; **Ralph Landau,** Sc.D.'41 . . . **Edward M. Davin,** Course XII, to Program Manager for International Decade of Ocean Exploration Program, National Science Foundation . . . **Emily L. Wick,** Ph.D.'51, Professor of Food Chemistry, M.I.T., to 1972 Chairman, American Chemical Society's Division of Agriculture and Food Chemistry . . . **Margaret L. A. MacVicar,** '64, to Trustee of Carnegie Foundation for the Advancement of Teaching.

Corporate Appointments: **Otto E. Wolf,** '29, to Vice President and Senior Engineering Fellow, Polaroid Corporation . . . **Howard S. Gardner,** '30, to Board of Directors, Technical Association of the Pulp and Paper Industry . . . **Gordon S. Brown,** '31, to Board of Directors, A.I.T. Foundation, Inc. . . . **W. L. Wise, Jr.,** '34, President, Henry G. Thompson Co., to President of A.S.M.M.A. . . . **Stanley E. Webber,** '41, to Vice President, Litton Industries, Electron Tube Division . . . **Frances R. Karlan,** '42, Assistant Vice President and Director of Dental Affairs, Medical Department, Metropolitan Life Insurance Co. . . . **Frederick J. Ross, Jr.,** '46, to Member of Executive Committee, American Supply and Machinery Manufacturer's Association, Inc. . . . **Robert W. Peach,** '47, to Vice President, Ameri-

M. A. Asnes

J. M. Peterson

can Society for Quality Control . . . **Marvin A. Asnes,** '49, to Vice President, Becton, Dickinson and Co. . . . **David Hardin,** '49, to National President, American Marketing Association. . . . **George H. Fernald, Jr.,** '51, to Assistant Vice President, Polaroid Corp. . . . **Robert W. Miller,** S.M.'52, to Vice President, U.S. and Canadian Photographic Division, Eastman Kodak Co.; **Robert A. Sherman,** '55, Vice President and Director, Finance and Administration, Eastman Kodak Co.; **Wylie S. Robson,** S.M.'56, to Vice President, International Photographic Division, Eastman Kodak Co.; **Robert B. Murray,** S.M.'68, to General Comptroller, Eastman Kodak Co. . . . **John M. Peterson,** M.A.R.'59, to Director of Planning and Business Development, International B.F. Goodrich Co. . . . **Wells Whitney,** S.M.'62, to Vice President and Director, Research and Development, Reprographic Materials, Inc. . . . **James N. Little,** Ph.D.'66, to Vice President, Waters Associates.

M.I.T. Appointments: **Samuel Goldblith,** '40, to Underwood-Prescott Professor of Food Science . . . **Samuel J. Mason,** Sc.D.'52, to Cecil H. Green Professor . . . **Joseph M. Patten,** Associate Director, Fiscal Planning, to Assistant Director, Information Processing Services and Director of Office of Administrative Systems. **Joel H. Spencer,** '65, to Assistant Professor of Applied Mathematics . . . **William G. Thilly,** '67, to Assistant Professor of Food Toxicology, Department of Nutrition and Food Science.

Deceased

Harry V. Allen, '01, November 30, 1971
James L. Wick, Jr., '06, March 16, 1972
William C. Bird, '12, April 5, 1972
David Guy, '12, May 7, 1972*
Robert J. Wiseman, '12, March 16, 1972*
George A. Inglis, '19, March 12, 1965
Holden M. Dougherty, '22, February 19, 1972
Duncan R. Linsley, '22, April 29, 1972*
Hugh D. McKinnon, '23, April 25, 1968
Harold M. Benning, '24, January 26, 1972
Floyd Pattison, '29, April 16, 1972
Burleigh M. Hutchins, '32, April 14, 1972
John J. Piotti, '40, May 5, 1972
Mahlon P. Etheredge, '45, July 12, 1971
*Further information in Class Review

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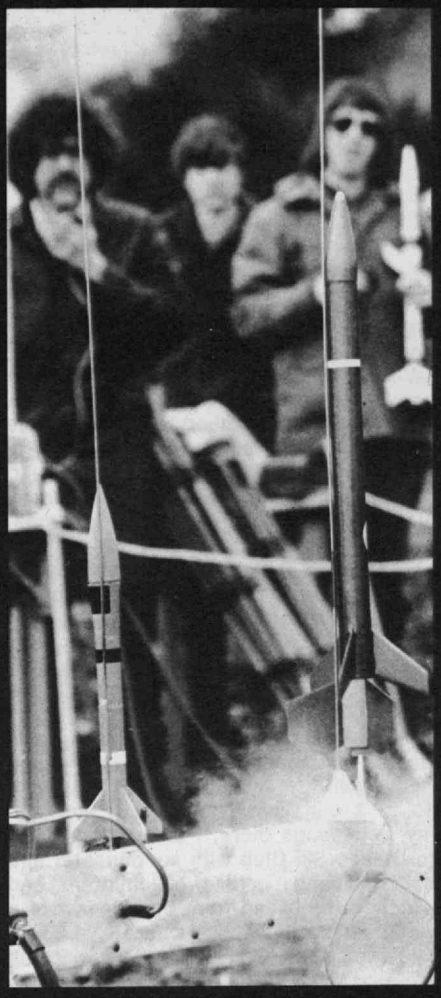
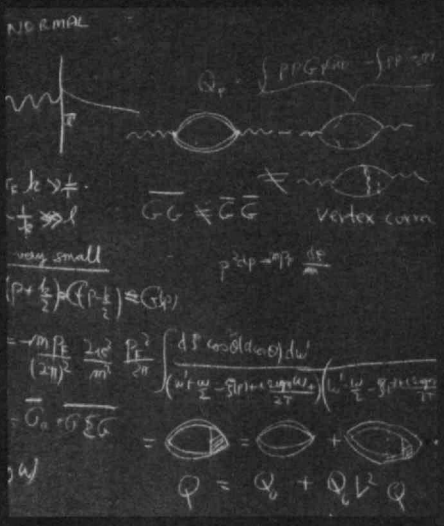




Scenes of spring at M.I.T..

The national model rocket competition brought several hundred hobby enthusiasts to the Institute—and to a field in Concord, Mass. (Photo: Boston Globe)

A unique colony of animals suddenly surrounded the office of George E. Valley, Jr., Professor of Physics who directs the Experimental Study Group for first-year students. (Photo: Margaret Foote)

Among the "hits" at a lethargic open house; tiddlywinks lessons from the world's champions, just returned from London. (Photo: Sheldon Lowenthal, '74)

Indigenous graffitti appeared on the electrical engineering construction wall.

When it came time to sell "brass rats," the Class of 1974 announced that this was the only class ring in the world not set with a stone.

Baker House brought new sounds to the campus one May afternoon with the Silver Star Steel Drum Orchestra; beer and joviality were free, said The Tech.
(Photo: David H. Green, '75, The Tech)

Class Review

95

Glad to report another telephone call to Tyrell Cheney, '03, found him feeling much better. With the aid of a walker, I am getting around the apartment. Miss the outdoors.—**Andrew D. Fuller.** Secretary, 1284 Beacon St., Brookline, Mass.

96

Professor King of M.I.T.'s Physics Department spoke at a recent meeting of local high school teachers about methods used to compensate for the impersonal atmosphere created by the large numbers of students attending the Institute. He described both the project laboratory concept and the newer "Concentrated Study." In the latter, a student may elect to spend full time for a month on one course, either before or after the regular term. Professor King was enthusiastic about the results of working with only 20 students in this set-up.

This called to mind an article I had seen in the '96 *Technique* in which there was a vivid description of three weeks spent by students and instructors of Course IV. They had gone to Newburyport, Portsmouth and Portland to examine, measure, analyze and discuss colonial architecture as found in selected buildings. Their report indicated that, in the nineties, the concentrated study had accomplished what the modern capitalized version intends to do.—**Clare Driscoll,** Acting Secretary, 2032 Belmont Rd. N.W., Washington, D.C. 20009

98

R. L. R. Bartholomew wrote that his father-in-law, **Walter Page,** died on February 15, 1972 at Devon Manor Convalescent Home in Devon, Pa. The following article, from the *Philadelphia Bulletin,* stated "Walter Page, a retired engineer and naval architect, died February 15. He was 96 and lived at Orrelby Farm, Chester Springs. Mr. Page was a partner in the former firm of Swasey, Raymond and Page, Naval Architects. During World War II, he was inspector of naval ordnance at the former Cramp Shipyard, Camden. He retired about 30 years ago after 18 years as an engineer with E. I. duPont de Nemours and Co. He was also the owner of the Page Shop of Haverford, a specialty store. Mr. Page was a charter member of the St. Anthony Club, Delta Psi which he joined in 1894, and a member of the Merion Cricket Club and the Corinthian Yacht Club.

"Survivors include two daughters, Mrs. Jean Webster and Mrs. Barbara Bartholomew; eight grandchildren and nine great-grandchildren." Our sympathy goes to his family who must be proud of him. He gave much service during his long life. At M.I.T. he took Course XIII, Naval Architecture, in an earlier class and because of an interim absence, became a member of 1898, graduating with a Bachelor of Science degree.—**Mrs. Audrey Jones Jones,** Acting Secretary, 232 Fountain St., Springfield, Mass. 01108

99

We are very grateful to Miss Flora E. Skinner, daughter of our late classmate Hervey Skinner, who was our faithful Class Agent for many years.

Miss Skinner found a Wakefield (Mass.) Savings Bank account in the name of "Class of 1899 M.I.T." Because the account with interest is $150.07, it is not of sufficient size to make it a trust fund from the Class. Rather, it is being sent to the Alumni Fund for 1972 as a donation from the Class.—**Norman E. Seavey,** Acting Secretary, Lucerne Towers, Apt. 514, Orlando, Fla. 32801

03

We have an interesting letter from our foremost classmate, Dean Emeritus **Andrey A. Potter** of Purdue University. He writes, "You were most generous and thoughtful to write me in February with the photograph in connection with the Caleb B. Smith award in Masonry.

"June 1973 will be the 70th anniversary of our Class at M.I.T. Let us plan to have a reunion in Cambridge on that occasion. There will be probably not many but we could have a simple get-together of those classmates who should endeavor to join us. Enclosed is a small check to aid in expenses. Our other classmates should make a modest contribution to complete our celebration. My health continues good and very comfortable. Warm greetings to you all, though in distant horizons."

A most interesting letter was also received from our distinguished alumna, Mrs. **Rosamond (Rothery) Vitale.** "Please do continue as Secretary of the Class of 1903. I think it is very kind of you to bother, but I suppose there aren't many left. My sight is gone, yet I do get great comfort from the 'talking books' put out for the blind."—**John J. A. Nolan,** Secretary-Treasurer, 13 Linden Ave., Somerville, Mass. 02143

04

I received a letter from **Frank Davis** which reads as follows: "I am doing fairly well. My son gets me to the office 10 to 2 p.m. most days and I work on my own things there. I did get up North to Otsego Ski Club with my daughter and her husband and two children and watched the skiing from the window of a well-heated club house where I was well taken care of. They did drive me one morning over 40 miles to my own Black Ring Ranch to see what was left after a big fire in December which burned up the '1913' wonderful log cabin, where I stay when I go up there during spring, summer and fall. The caretaker's quarters, kitchen and dining room also burned. They say they will rebuild this spring. There are still three buildings left; the barns are OK and my jeep is still there. It was a shock to all of our 30 members."

We have some additional information on John W. Shaw whose death was reported in the January issue. **John Whitman Shaw,** whose active career in Canadian mining spanned 45 years, died on February 13 in Annapolis Royal, Nova Scotia where he had been living in retirement since 1951. He was 92. His mining career was identified chiefly with the Cobalt, Ontario, silver camp during its early days and peak years of production, and with gold mining and exploration in Northwestern Ontario in the 1930s. His discovery of Gold on McKenzie Island in 1929 and the subsequent development of the McKenzie Red Lake property helped to stimulate the Red Lake Mining boom of that period. In 1904 he graduated from M.I.T., with a degree in mining and was employed successively at three Nova Scotia gold properties, the Kemptville mine, the Micmac mine at

North Brookfield and the Boston Richardson mine near Isaac's Harbour, before moving to the mushrooming Cobalt camp in 1907. In Cobalt he was a staff engineer with the Trethewey, King Edward and Cochrane mines.

In the 1920s, John worked briefly as a field representative for Mining Corporation in B.C., and returned to Northern Ontario where he specialized in field work and set up a consulting practice in New Liskeard. He also acted as consultant for numerous companies with mining properties in Ontario and Quebec. In 1936 he moved his office to Toronto where he remained until his retirement in 1951. He was a long-time member of the Canadian Institute of Mining and Metallurgy and of the Engineers' Club in Toronto. His wife died in Annapolis Royal in 1962.—**Eugene H. Russell,** 82 Stevens Rd., Needham, Mass.

05

Just as we were running out of news, along comes a notice of a new honor for our **Doc Lewis**. He has just been elected a Fellow of the American Institute of Chemical Engineers "in recognition of his superior work with distillation and heat flow." With this notice is a summary of the degrees (some honorary) in this country and abroad, numbering six, and of his membership in eight national academies and societies. We have mentioned these at different times. Doc is so modest, he has never written us about it.

I have a copy of a letter from the Cohasset, Mass., Board of Selectmen to **Gilbert Tower,** Course XIII, commending him on his years of service to the Town of Cohasset. Gilbert had voluntarily given of his time to statistics, maps, plans etc.

I have received a newspaper clipping telling of Ethel (Mrs. **Prince**) **Crowell**'s death. Those who attended many of our reunions at Old Lyme, Conn., and Cape Cod, will remember her as a very moving spirit. I knew of her illness at the time of Prince's death. She survived him by just a few weeks.

Our Class had a pre-67th Reunion in Bermuda early in April. Present: Ruth and **Izzy Nye** and **Charlie Smart.** We had a jolly good time and drank a few toasts to 1905. By the time you read this we will have had our official 67th on Alumni Day at Cambridge. From reports to date we should have a fairly good attendance. —**F. W. Goldthwait,** Secretary, Box 231, Center Sandwich, N.H. 03227

07

We have news that **William G. Perry** received an honorary degree of Doctor of Fine Arts from the College of William and Mary, Williamsburg, Va.

The degree, presented on June 4, 1972, was in recognition of Mr. Perry's outstanding service in the field of architecture and in particular recognition of his contributions to the early restoration of Colonial Williamsburg.

Walter Kirby sent us this very pleasant note from his home in Lakeville, Conn.: "As Father Time is catching up with me, I am leaving my present home and garden, as well as my many bird friends, chipmunks and snakes. On June 26, I am moving to a retirement home just being constructed in Salisbury, Conn." Walter closes his note with a grand Cheerio and notation of his new address: Noble Horizons, Apt. D-1, Salisbury, Conn. 06068.—**Kathy Sayre,** Class Notes Editor, Technology Review, E19-430, M.I.T., Cambridge, Mass. 02139

11

I quote from a letter received late in April from **Marshall Comstock** "I spent most of my working years with Wagner Electric Co., of St. Louis as sales engineer and branch manager. I retired when I was 65 and Helen and I have had some fine cruises including two around the Mediterranean and one in the Caribbean. We are now back in my home town of West Medford at 422 High St., and are trying to get used to apartment house living. We have been going to Maine, near Rockland, for the summer months and to St. Padre Island for three months in the winter. So we chase the good weather and the postman chases us. We are in fairly good health and are able to get around. Our family consists of three children, nine grands and five greats, ranging in age from Barbara, 53, to Teather, 9 months." I planned to call on the Comstocks but was too slow as they left for Maine the first week in May.

On May 10 Margaret and **Bob Morse** had Gertrude and **O. W. Stewart** and me to lunch at the Yankee Clipper Steak House in Sandwich. Besides the good lunch we had a fine time talking. After lunch we had a personally conducted tour through the Sandwich Glass Museum—a really remarkable place. Bob has been connected with the museum for many years and last year was chairman of the committee that built a good sized addition onto it. Bob has promised to write up the story of his association with the museum for some future Notes.

I have had two other letters in the past month. **Harry Tisdale** of Ft. Myers Beach, Fla., says I am only one of several with whom he corresponds regularly. Some of his neighbors live there only in the winter and he looks after their property while they are away. . . . **Frank Smith** in Honolulu says he reads, eats, sleeps and plays shuffleboard. He is living in a retirement home that he says is the best in the world. He is about three years older than most of us as he worked for a while between high school and Tech; and he is not in robust health—**Oberlin S. Clark,** Secretary, 50 Leonard Rd., N. Weymouth, Mass. 02191

12

DO YOU REMEMBER our 55th reunion held on the campus from June 9 to 13, 1967 with an attendance of 24 members and a supporting group of 13 wives? At that time our program was quite similar to that planned for this year. We enjoyed a campus tour by bus and inspected the various new buildings, then took a trip through the new Boston, including the Prudential Tower, the new City Hall and other developments in the North End. Then we went by bus through the countryside to Sudbury for luncheon at the Wayside Inn, followed by a cocktail party in the McCormick Hall penthouse. Instead of the Pops Concert, entertainment was furnished in Kresge Hall by a group of musicians from Mexico. It is interesting to note that of the 22 men now registered for our 60th reunion, all but two attended in 1967, and three others are no longer with us. A full report of the activities will be included in the October-November issue of the *Review.*

Good news—which you already know if you were present. **Johnnie Noyes**

R. Wiseman, '12

wrote an enthusiastic letter in late April saying that recovery from his March heart attack was so good that he could be with us. . . . **Jesse Hakes** and Mary have just returned from their three-months cruise to the Orient and South Pacific, a report of which is expected. They have, however, decided that they should cancel their planned reunion trip. . . . **Hamilton Merrill** and Phyllis report that they are in good health and celebrated their 50th wedding anniversary last October. Ham has given up his several community interests in Bridgeport, Conn., and they have moved recently to the old homestead on Cape Cod in Orleans, Mass. (Box 313) where they were married. Here he expects to find other interests to keep him busy. Four of his nine grandchildren are now married and he hopes that the three great-grandchildren will soon increase in number. Our congratulations!

Willis Salisbury, our perpetual traveler, writes that he spent an enjoyable winter in Hawaii, with parts of it on three of the islands. "On Oahu, I visited and was entertained by some very good Japanese friends. One was a Nisei during World War II, and was in training for special intelligence work here in Minneapolis, where I met and befriended him. He and his lovely wife entertained me in their home near Honolulu, as well as in one of the best hotels. After about six weeks I moved to Maui for a week or so, and then to the Big Island (Hawaii) for ten days. I had previously done quite a bit of reading about the Island's history which added much to the enjoyment of my trip, including Pearl Harbor and the big volcano on Hawaii. This volcano had been acting up for several weeks, and produced a real show for us tourists. I had an interesting experience at Easter time, when I attended Masonic services of the Scottish Rite. The members included Chinese, Japanese, Hawaiian and whites. It gave me a very humble, awed and thankful feeling to see all of these races occupying the different chairs of office. After the ceremony on Easter morning, I was asked to address the meeting. I also attended several Kiwanis meetings, and everywhere the same spirit of brotherhood and co-operation was noted."

Howard Cather writes, "I am pleased to report that a doctor's recent report put my health down as 'unusually good for my age'. The only recent activity of interest was the fine party my wife, Liez (Wellesley, '21) put on at her club to celebrate my 85th birthday. I have already reported our winter vacation at Siesta Key, Fla., which I plan to repeat next year." . . . **Paul Tyler,** whom we visited last winter at his home in Holmes Beach, Fla., also reports a cruise: "I wish to tell you again about the splendid job you are doing as our class secretary. Now that you have extracted some kind of a report from nearly every surviving member of our Class, it would be too much to expect much in the way of a continuing flow of interesting news. You have reached what the economists call, 'the field of diminishing returns', and the harder you work, the less you may get. However, I wish to encourage you to keep trying. We are not attending the reunion, as with two weeks in Washington in May and a later trip scheduled for up north, we cannot take it. We are still recovering from our Caribbean cruise on the new R.M.S. *Southward,* recently commissioned and touted as the last word in luxury and convenience, so we are probably spoiled by memorable trips on other ships, which we liked better. Our chief complaint was the crowding, with 925 passengers the number was about 50 percent greater than some liners twice as large. It reminded me of Coney Island on a Saturday afternoon. We could not walk ten feet in a straight line. The only redeeming feature was that the food was good."

We must sadly report the sudden passing of **Dave Guy** on May 7, 1972, in Washington, D.C. He was one of our older classmates at 86 years and a very active and loyal alumnus who had had his heart set on attending the Reunion. He wrote me frequently and I am sure all of us enjoyed his philcsophical quotations and comments, the last of which appeared in the June issue. Dave underwent a serious abdominal operation in April and hope for his recovery was minimal. He was active for many years with the U.S. Chamber of Commerce in Washington, D.C., and had served as its manager of natural resources. He was also active in many community projects until quite recently. His survivors include his wife, Iva, a married son and a daughter and three grandchildren, all living in the vicinity. We have expressed to them our sympathy and that of the Class of 1912.

I have belatedly learned of the sudden passing of Dr. **Robert J. Wiseman** on March 16, 1972, in Waltham, Mass., following a broken hip and then a heart attack. Bob had lost both his sisters whom he had been living with after his formal retirement two years ago. He then moved to a retirement home where the accident occurred. Bob was also an active alumnus and regularly attended our annual class dinners. He had been an executive of the Okonite Co., of New Jersey for over 20 years and also served as president of the Insulated Power Cable Association. The A.I.E.E. awarded him special honors for his research on high voltage cable work and in 1959, Okonite dedicated their new plant in his honor. He has no survivors.—**Ray E. Wilson,** Secretary, 304 Park Ave., Swarthmore, Pa. 19081

13

The Capens have been socially busy the past two weeks after several months of winter confinement. We have enjoyed a pleasant evening with a social hour and dinner sponsored by the Biddeford and Saco Rotary Club "Ladies Night" in Old Orchard Beach. Last week, we enjoyed attending the M.I.T. Club of Western Maine's spring dinner meeting at the Holiday Inn, Portland, Maine. There were about 50 members attending and it was particularly gratifying to greet Charles F. Hobson, '11, formerly of Lowell now residing in Portland. Charles and yours truly were members of the A.T.A. over 60 years ago. We were greatly pleased to meet John B. Babcock, Jr., '10, the secretary of the Club who had invited us to this spring meeting.

Again, we are indebted to the Alumni Fund Organization for a note from **William N. Flanders,** now residing in Sarasota, Fla., "I graduated from M.I.T., Course I, under Professor Spofford in 1913 and married Helen Hoyt Macartney, Wellesley College, '11, in fall of 1913. Went to Niagara Falls, N.Y., fall of 1913 as engineer in Hooker Electrochemical Co. Became an officer of same. Left and became a partner in R. J. Macartney Co., Lawrence, Mass. Sold my interest and went to New York to Union Carbide Co. in 1936. Retired at 65 years of age. Helen died in our home in Sarasota, Fla., March 25, 1971. I have one daughter, Wellesley, '38, and four grandchildren, two of them with master's degrees and two graduating from different prep schools in Andover, Mass., on June 10 this year. Which graduation should I attend boy's or girl's?"

Further, it was a pleasure to hear from **Kenneth Hamilton** and we quote: "Thought it about time I paid my dues so here is a check for two bucks. I was most shocked to read in the *Review* about Charles Thompson as we played baseball together on the class team. Then when in high school we played baseball, he on Winchester and I on Medford, Mass. We shared the same room when we both started to work in Brockton, Mass., he with the Avon Sole Co., and I with the George E. Keith Co. Well, such is life and the years go fast. Hope you are OK and like living in Biddeford, Maine."

Remember that our 60th Reunion will occur June 1973. Are you saving up energy and cash for that event? As always write us today about your activities, hobbies, and opinions of this modern age.—**George Philip Capen,** Secretary and Treasurer; **Rosalind R. Capen,** Assistant Secretary, Granite Point Rd., Biddeford, Maine 04005

14

After his return, late in April, from a Caribbean cruise, **Ray Dinsmore** wrote, "We had a nice vacation which was quiet

and restful and Violet and I both enjoyed it. We had a long, pleasant cruise from Ft. Lauderdale to Aruba in the Netherlands Antilles. There isn't much at Aruba except what is connected with the oil refineries but they have put up a few new hotels and houses since we were there last. A man at our table was an ex-sea captain who spent 30 years at Aruba with Standard Oil, supervising the scheduling of oil vessels in and out of the port.

"The next morning we went to La Guaira, the port for Caracas. However, we had decided not to go into Caracas; I personally do not think the atmosphere is very friendly toward Americans. As it turned out, one of the tour buses into Caracas was held up near the university and the passengers were robbed. They painted on the sides of the bus, 'go home Yankee.' The police later said these were university students and that it was done to embarrass the government.

"The following day we were at Margarita which is also Venezuelan, progressing from there to Martinique in the French West Indies, a place we had previously enjoyed, we wandered around the town from one shop to another, chiefly interested in their low prices for French perfumes, but finding some other small and somewhat unique curios as well. The old capitol was completely destroyed by the volcanic eruption from Mt. Pelee in 1902. It seems that a candidate for Governor at the time, who did not want his voting constituents disrupted by what he thought was a false alarm, persuaded the people to stay in their shops and houses until it was too late. Sixty-thousand people were killed, the entire populace except for one prisoner in the dungeon. He was badly burned but after his recovery made his living by traveling around with Barnum and Bailey. The small museum contains the few articles that were recovered and it shows the intense heat that must have prevailed.

"We made our last stop at St. Thomas in the Virgin Islands. The harbor was very rough and this made getting in and out of the lighter a somewhat precarious proposition. St. Thomas is a very attractive island and we had planned to revisit some of the places we had previously seen in the mountains and beaches. However, a cold weakened our ambition and we decided to return to the ship and take it easy.

"So, at 1:00 a.m. the ship sailed on Friday for Florida and we made a timely landing early Monday. Such a journey gives a real change of atmosphere, an opportunity to meet new people and to get a break in the weather which has been very erratic in Akron this winter and spring.

"You spoke of your regret that we are not to have a class reunion this year and I feel somewhat disappointed too, but there seems to be a very limited enthusiasm for it, so rather than have a mere handful, I think the decision to call it off was best. Perhaps for 1974 we can come up with a few new ideas that will be more attractive."—**Charles H. Chatfield,** Secretary, 117 Steele Rd., West Hartford, Conn. 06119

15

The "Class Supreme" supremes again. At lunch at the M.I.T. Faculty Club on April 21, 24 Classmates and sons gathered for another class luncheon. It's a pleasure to record that the long distance men "out-supremed" us local guys —**Larry Bailey** and his son Bob, '41, **Bill Brackett** and **Ray Delano,** Duxbury; **Whit Brown,** Concord; **John Dalton,** Providence, R.I.; **Jack Dalton** and **Pop Wood,** Peterboro, N.H.; **Harry Murphy,** Hingham; **Charlie Norton,** Martha's Vineyard: **Stan Osborn,** Hartford, Conn.; **Larry Quirk,** Middletown, Conn.; **Fred Waters,** Marblehead; **Max Woythaler,** Framingham; and the winner **Sol Schneider,** Philadelphia. Also **Dinger Doane, Clive Lacy, Horatio Lamson, Azel Mack, Archie Morrison, Wally Pike,** The **Pirate** and **Gerry Rooney, Bill Sheils.** We were sorry to have last minute cancellations from **Larry Landers** and **Wayne Bradley**—better luck next time! A fine group of classmates and old friends.

The old Pirate back again sailing the high seas led us with his nostalgic "We are happy" cheer. An hour of cocktails and a delicious lunch put us all in good mood for Jack Dalton's cheering and encouraging words about conditions at M.I.T. and the job our new President, Dr. Wiesner, is doing there. It's impressive that many who could not come had interest and feeling enough to send regrets and regards: **Henry Daley, Phil Alger, Joe Livermore** from Kingston, Jamaica, and **Jim Tobey** who sent regards to all the OLD CROCKS! Now, what do you suppose he meant?

This meeting here at noon-time has been well received by all and is agreed to be a much more comfortable arrangement than an evening meeting. . . . **Wayne Bailey**'s Boston office at 739 Boylston St., Boston 02116, is open for any of you who want to book a pleasant summer holiday at his Moosilaukee Inn, Warren, N.H. At lunch recently with Wayne he told me of some elaborate plans for the Inn this summer. . . . **Sam Berke** wrote from his Deep Lake Farm, Lakeville, Conn. "Your invitation to the luncheon on April 21 was appreciated but I just could not make it. Evelyn and I spent most of the winter here on the farm. We like Thanksgiving and Christmas with the family and nothing is cleaner and prettier than snow. We set up a deer feeding station near the house and had plenty of customers all winter."

Ben Neal wrote "I was really very sorry not to be with you, last Friday, but the plans that I had made didn't fit together very well. I am sure you had a great party, and it is always a disappointment not to see the old gang." Ben was planning for his annual Spring fishing trip in Canada and we hope he brought back some good "keepers."

All the best to you and your families for a happy and enjoyable summer. Keep well and write when you can to "help Azel".—**Azel W. Mack,** Secretary, Apt. 26A, 100 Memorial Dr., Cambridge, Mass. 02142

16

Now it is history—all that "scenic and refreshing beauty of the Cape shoreline" that our good president **Ralph Fletcher** told us was beckoning, when he announced in April that the 56th reunion was again to be held at Chatham Bars Inn. And once again the wise regulars and others who attended, shared the wonderful experience of another reunion in our favorite spot. An account of all the doings will be given in the first issue this fall.

Late in April, we had an example of how one can be free and really on top of the world. We can't all do it the way **Izzy Richmond** does, but here's his beautiful example: He writes: "A week ago Sunday, a brilliant beautiful day, I decided to go flying. Filed a flight plan for Burlington, Vt., and took off into a very turbulent head wind and after bouncing around for a couple of hours climbing over the 4,600-foot mountains I arrived in Burlington at lunchtime. Called one of Anne's Wellesley classmates and got myself invited for lunch. On the return trip, I had solid white clouds below me and all blue skies above. I could not see the earth or any other airplanes. It was my own grand world! Taking advantage of the tail wind the return trip took only about an hour and 20 minutes."

Mac McCarthy keeps busy in what he calls "sundry ways." He was called on to present the 1971 Elmer A. Sperry Award, "established in 1955 to commemorate the life and achievements of Elmer A. Sperry whose genius contributed many advances to the art of transportation. He pioneered in work with the storage battery, one of the first electric automobiles, an electric trolley car of improved design, a rail flaw detector, a gyro-compass and a course recorder and automatic steering for ships, an airplane gyropilot and other air-navigational instruments. Mac is a member of the Board of Award which is composed of two representatives from each of the five major engineering societies. Mac has been one of the representatives of the American Institute of Aeronautics and Astronautics for several years, and is this year's chairman. Mac made this year's award at the Annual Banquet of the Institute of Electrical and Electronic Engineers held in March in New York. As he noted: "The award recognized the engineering skills and ingenuity which has over the past 30 years led to the introduction and expansion of Centralized Traffic Control on railroads all over the world."

From **Charlie Lawrence** we received a section of the March 28 *Boston Herald Traveler* with an article on "The Einstein Papers" and a picture showing Einstein with "Delegates of Brandeis University in 1946 meeting in his Princeton, N.J., home to discuss plans for the Waltham school." To us, one of the most important things about the picture is **Barney Gordon.** With a little prodding at the reunion in June, Barney can tell you more about Einstein, this particular picture and

the happy occasion it represents. You may have to try hard, for Barney is not noted for talking about some of his many successes. . . . **Frank Darlington** of Leetsdale, Pa., in the winter, and Cape Cod (Squaw Island, Hyannisport) from June to October, has an interesting statistic to offer as he answers some of our questions relating to what doing, where been, who've seen and philosophy. As for what-doing, he says: "Calculating and paying the multitudinous taxes that pop up during the first four months of the year. I filed my first income tax return in 1917. I think it interesting that my income has in the intervening years increased 53 times and taxes 2,260 times." And under "philosophy" he notes that old age is certainly all it's cracked up to be!

In April, Nell and **Don Webster** closed out their two-and-a-half-month stay at the Bay Tree Club in Sarasota, Fla. They speak enthusiastically of Ruth and Emory Kemp's post-Cape Cod adopted homeland. "The spring weather here is divine and Nell and I are reluctant to leave so early. I live in shorts and sandals, topless, and Nell comes as close to it as her dress code will permit. The Siesta Key beaches are superb and ideal for long walks. In February I attended a luncheon meeting of the M.I.T. Club of Southwest Florida and met up with **Emory Kemp** and **Andrew Witherspoon.** Also ran into a number of acquaintances from other classes." . . . **Ned Hewins** is right when he says, "There is nothing very funny about the approach to age 80. So when I run across a joke about it, I like to share it with others who are in the same boat. A Roman senator approaching 80 was lamenting to his secretary (who was sitting on his lap) about his age. 'Oh!' said the secretary brightly, 'LXXVIII isn't old.' "

Earl Mellen of Millburn, N.J., is finally going to give up another of his long-term activities, as chairman of the Hospital Plan of New Jersey. Earl says that with six children and 16 grandchildren, "There always seems to be something to do." And now he's keeping tabs on how many grandchildren are in college, about to go to college, about to get married and all such vital statistics. . . . Good old Colonel **Frank Hastie,** down in Dowell, Md., has some reminiscences of his days in the Engineers Corps. Speaking first of his present tendencies, he notes: "My first idea, when I see something that needs to be done, is whether tomorrow or maybe next week will be time enough while Amelie always tries to take care of something at least last week. Which reminds me of Somervell's advertising during the war: 'If it is easy, we did it last week; if it is difficult, we will get it done tomorrow; but if it is impossible, it will have to be done next week.' Well, some draftsman with a sense of humor drew an engineer castle (like on our insignia, except it sagged in the corners, had a clothes-line of untidy wash on the roof, and had a more or less decrepit appearance) and came up with this slogan for a take-off on Somervell's: 'If it is easy, we can make it difficult; if it is difficult, we can make it impossible, *but* it will take time.' Oh, boy!"

A suggestion: What to do with those old postcards you picked up in travels around the world? Use 'em! That's what we've been doing and others, too. They make a most acceptable mode of communication. The latest from **John Fairfield** is a vintage 1920 old-timer—a faded picture of the Hydro Electric Plant of the Mississippi River Power Co., in Keokuk, Iowa. Writes John: "I was awarded a trip to St. Louis via Keokuk for keeping my word to return to teach after forfeiting a 33 per cent raise in salary elsewhere." Using cards like this, he says, illustrates something that goes with Scottish blood, "Waste not, want not!" . . . We had word, thus, from **Hank Smith** in March: "Have just finished four years in the retirement community of 'Leisure Village' in Lakewood, N. J.—a very well-run organization. Now going it alone as Dorothy died on January 14 this year." . . . And **Frank Holmes** writes as "probably one of the few members of the Class of 1916 that remains active in this life's occupation. Went into my father's business right from M.I.T., and put in my 56th Thanksgiving and Christmas turkey rushes in November and December. Still sell M.I.T., Harvard, Wellesley, Brandeis, etc. Just returned from five weeks vacation at Treasure Island, Fla. Looking forward now to spending considerable time at our summer house in Fitzwilliam, N.H., this summer."

Another 16er who continues fully active in his business specialty is **Doug Robertson,** who wrote in April: "We built a plant in Belgium in 1969 and it has required frequent trips to get it straightened out. Our licensed English plant exhibited in Paris last May, and will exhibit this May in Dusseldorf, and our American plants will exhibit this coming fall in Greenville, S.C. I plan to spend a few days at these exhibitions." . . . Near the end of April, **Victor Dunbar** of Sydney, Nova Scotia, called your Assistant Secretary just to say he was off on another trip and planned to visit Portugal, Spain, Naples, Switzerland (one or two-week stop), Rotterdam and winding up in Devon, England.

And now we look forward to the summer vacation months. Do have a pleasant and restful time wherever you go, or in a comfortable snoozable back yard chair if you don't go anywhere. But please keep in touch with your ever-willing-to-work Secretaries, with new or old picture postcards, plus bits of this and that to help keep the 1916 column as full and interesting as possible.—**Harold F. Dodge,** Secretary, 96 Briarcliff Rd., Mt. Lakes, N.J. 07046; and **Leonard Stone,** Assistant Secretary, 34-16 85th St., Jackson Heights, N.Y. 11372

17

As these lines are being written, your Secretary is gathering strength in sunny Florida for his activities at Chatham Bars in a week or so, and is conserving his energies. He says "That gayly painted, much publicized, 17-car (please note) Auto-Train that delivers automobiles and their passengers from suburban Washington to Sanford, Fla., overnight saves 1,100 miles of driving. The **Stan Dunnings** found it a help for their Naples, Fla. sojourn going and coming." He also reports that the **Don Tarpleys** spent a satisfying holiday in Bermuda, and word from **Tom Meloy** speaks of the great time he had for several weeks on the Riviera and in Italy and Spain.

It is with great regret that we have to report the loss of two classmates. **Walter A. Wood** died in Rochester, N.Y., on January 27, 1972, after having been seriously ill for more than two years.

James Dexter reported the death of his grandfather **Franklin C. Dexter,** on March 20, 1972, with an obituary from the *Bound Brook* (N.J.) *Chronicle.* A letter from Mrs. Dexter points out that her husband had been superintendent of dyeing and coloring at Cheney Brothers in Manchester, Conn., for 14 years before retiring from American Cyanamid Company in Bound Brook, N. J. after 25 years with them.

A letter from **Rad Stevens,** who had previously expressed his regret at not being able to be at the 55th says "Physically I am coming along pretty good, but just don't like to get away from my doctors and home." But he enclosed a clipping from the *Elgin* (Ill.) *Courrier News* which records the fact that Rad, as the oldest member of the local "Y", plastic hip and all, swims 200 yards a day in the local pool in preparation for the 100 eighteen-hole golf matches he wants to play this summer. Quite a change from the Rad Stevens who as anchor man on our Freshman Tug-of-war Team on Field Day, 1913, couldn't be moved!

Alumni Day events and our 55th Reunion were successful in every way. At the "Class Gift" time our Al Lunn made an innovation by way of announcing a 55 Year Gift. It involved the making final of our class insurance program as initiated by Ted Barnard in 1930. That Fund had now reached $100,000 and becomes the 1917 Memorial Fund. The income goes to M.I.T. for unrestricted use. In addition $80,868 as down payment was made on the $100,000 Buzz Aldrin Scholarship Fund.

The details of events of our 55th will be forthcoming in the October/November issue. It was agreed that Tubby Strout had run about the best reunion ever for the 73 attending enjoyed a fine get-together at the lovely Chatham Bars Inn.—**Stanley C. Dunning.** Secretary, 6 Jason St., Arlington, Mass. 02174; **Richard O. Loengard,** Assistant Secretary, 21 East 87th Street, New York, N. Y. 10018

18

Our industrious Secretary and his wife have gone on another trip so the Notes for this issue have been prepared by **Len Levine.**

Julian Avery advises from Chestnut Hill, Mass., that all is well. He is very busy working on two important projects, the details of which will come later. . . . **Henry Blank** writes from Short Hills, N.J., that he retired in 1971 and is now working daily as a volunteer for United Fund of Newark. How about a longer letter, Henry? . . . **Walter Herfurth**'s card from Tucson, Ariz., boasts that he is the old-

est member of our Class. Congratulations to Walter, with January 25, 1891, as his birthday. Does anyone challenge him? I think **Ben Ballantine** is close. . . . **Charley Dimock** of Methuen, Mass., advises that he is working part-time just to keep occupied.

With regret, we report that **Roy Simpson** died April 16, 1972, at 76 years of age. He was a World War II, U.S. Marine Captain. Later he was a distinguished engineer at the Lynn General Electric River Works for 38 years until his 1961 retirement.

John Poteat writes from Tryon, N.C. He is eagerly anticipating our 55th in 1973. The Poteats are taking a delightful two-month trip including East European capitals, Austria and England. John, why not send in the highlights? . . . John Poteat also sent in a newspaper clipping regarding **Al Sawyer** who died last year. Al had been an energetic director of the Ormond Beach, Florida War Memorial Art Gallery and Gardens. A plaque was recently unveiled in honor of Al's outstanding efforts. . . . I was recently pleasantly surprised to meet **Eli Berman** on the way home from a bridge game. Eli keeps busy. Last year he did consulting work for five months, spent six weeks at a beautiful beach in Spain with Dolly and also played much golf. He looks and acts peppy and young. I think he has discovered the Fountain of Youth or he is taking Geritol. I wish sometime that Eli would give us the story of how he built a very successful chain of retail radio and television stores in the Greater Boston area and how his M.I.T. electrical engineering background was helpful. Also how he went back to school only a few years ago to get his master's degree. What say Eli? Drop us a line.

Some of you who review the Class Notes have interesting old or present experiences that your classmates would like to read about. Why not sit down now, write them in detail and send them to one of your Secretaries. If any of you would like the names and addresses of classmates in your area, that you could contact for news, let us know.—**Leonard I. Levine,** Assistant Secretary, 519 Washington St., Apt. 15, Brookline, Mass. 02146; **Max Seltzer,** Secretary, 60 Longwood Ave., Brookline, Mass. 02146

19

John J. Hanson passed away on December 1971 in Cranford, N.J., at the age of 86. He joined the Walter E. Lummus Co., in 1923 and retired from there in 1953.

A note from **Arthur E. Gorman** from Ormond Beach, Fla., states that on Easter Sunday 1972, the Directors of the Ormond Beach War Memorial Art Gallery and Gardens "paid well deserved memorial honors to Albert F. Sawyer for his many years of service as Treasurer of this civic organization. Al, Class of '18, died September 2, 1971 and is buried but a few blocks from this war memorial."

E. R. Hubbard writes from Southern Pines, N.C., "One of these days I hope to get back and renew some of my old friendships." . . . On Palm Sunday, March 25, 1972, **Harry A. Kuljian** was awarded the citation of man of the year by the parish of the St. Sabag and St. Mesrob Armenian Church in suburban Wynnewood near Philadelphia, Pa.

Addresses from the Alumni Association include **Howard H. McClintic, Jr.,** 1415 Bennington Ave., Pittsburgh, Pa., and **Harold C. Moberg,** 27 Vinton Terrace. Rockland, Mass.

Nelson A. Bond, phoned May 11 and has retired from his Washington, D.C., Pentagon assignment. He now resides at 2114 Rankin Rd., Schenectady, N.Y. 12309. Phone (518) 372-6749. . . . Your Secretary will be in Canada in August and around the Northeast before and after.—**E. R. Smoley,** Secretary, 50 East Rd., Apt. 11E, Barr Terrace Apts., Delray Beach, Fla. 33444

20

Not many of us can talk any more about having a summer "vacation" but, anyhow, may your summer prove pleasant and recreational.

Glad to see that Billie and **Dick Gee** are back at the sea ranch in South Dartmouth. . . . **Bob Tirrell** has picked up stakes and removed from Englewood to Lebanon, N.H., at 90 Bank St. Welcome back to New England, Bob. . . . **Lyman Whitten** and his wife have been touring Europe, mostly Spain, and are back in Washington by now. . . . **Frank Hunt** is no doubt enjoying his lovely summer place in West Boothbay, Maine. We hope to catch a glimpse of him some time when visiting our son at his summer camp in Southport.—**Harold Bugbee,** Secretary, 21 Everell Rd., Winchester, Mass. 01890

21

Allen Addicks of South Pasadena, Fla., authored a fine letter of reminiscences received by your Secretary recently. Al was captain of the boxing team at M.I.T., **Josh Crosby** was manager and Crawford Greenewalt, '22, was assistant manager. Al recalled a party at the Phi Kappa Sigma house in 1920 where 150 brothers, feeling no pain, shook the house to its foundations. A complaint from three old ladies down the street resulted in a call from Dean Burton for an accounting—to which Harold Lobdell, '17, a resident of the house, responded. Years later when Lobdell was Dean, a similar party at Lambda Chi Alpha across the street brought forth another complaint from the same three old ladies. Lobby insisted that the ladies knew what they were talking about.

Another reminiscence concerned **Watts Humphrey,** described by wrestling coach "Cyclone" Burns as the most powerful man he ever wrestled. Al also wrote that he once owned a 1912 Marmon Yellow Jacket bought for $200, used it for six months, and then sold it to Crawford Greenewalt with a warning it might have a major breakdown at any time. It did! The same model car recently sold in the Parke Bernet Galleries in New York for $20,000. Says Al, "If Crawford reads the '21 Notes, I pose this question. Doesn't he think he owes me a finder's fee of 5 per cent, say, $1000?"

Three members of the Class attended the May meeting of the M.I.T. Club of Northern New Jersey at which President Wiesner was the honored guest and speaker. **Cac Clarke** spoke briefly to urge attendance at the 25th Fiesta in Mexico next year. **Joe Wenick** introduced Dr. Wiesner who talked about curriculum and teaching innovations and the need to get further into social and environmental areas. The Club established a new class of membership—Honorary Life Member—and elected Joe Wenick as its first recipient. Dr. Wiesner, Cac, Joe and your Secretary all wore their 1921 red blazers.

Leo C. Pelkus writes that he and Vivian recently returned to their home in Wellesley Hills after a winter sojourn at Key Biscayne, Fla. He is semi-retired but still enjoys working a few hours a week as a consultant to the firm he founded 30 years ago. It would appear that **Richmond S. Clark** who believed he had known Ray St. Laurent longer than any other class member is a runner-up to Leo Pelkus and **Saul Silverstein.** Leo writes that Ray, Saul and he were in the same seventh grade class at the Roger Wolcott School in Dorchester, Mass. Can anyone beat that? Leo attended Helen and Ray's wedding. From Dorchester High School there were six entrants to the Class of 1921: Leo Pelkus, **Herb Reinhard, Dick Poole, Donald Piston, Richmond Skinner** and **Ernest Gordon.** Says Leo, "I hear from **Arnold Rood** on occasion and was sorry I missed finding **Eddie Haywood** at Pops last June."

Assistant Secretary **Samuel Lunden** sent along three letters he had received in response to queries to fellow Californians. **Arthur E. Raymond** of Los Angeles retired from Douglas Aircraft in 1960, but continued as a consultant for Aerospace Corp., N.A.S.A., and the Rand Corp. He reports he is gradually phasing down and has plenty of time for travels. His favorite spot is the little town of Hana on the island of Maui in Hawaii, where they regularly spend Christmas and New Years. He and his wife are foster parents of many former U.C.L.A. foreign students whom they visit in travels to Europe, Asia and Africa. . . . **Williston Wirt** of Claremont, Calif., enclosed a clipping captioned "Seeing Mexico Via a Private Pullman" which describes a trip he and Genevieve took last Christmas. It was a 5,000-mile trip from Juarez to the Guatemalan border and sounds wonderful. Will recommends the two-week trip to any traveller considering a trip to Greece or Egypt. "The archeology is fascinating and they say that three-fourths of the ancient cities of Mexico are still buried, awaiting restoration." . . . **Robert Brace Crawford** of Oxnard, Calif., wrote that his life subconsciously has been directed to finding ways and means to make less energy do more work. His firm is currently engaged in trying to find an economically balanced solution to the sun, smog, ozone, nitrogen-dioxide problem in the Los Angeles basin. Quite an assignment!

Wallace T. Adams of Middletown, Ohio, reports plans for travelling to Southern Ireland, Scotland and England during

June. A lot of the three-week journey will be by bus in the rural and historical parts of the British Isles. In April Wally had both wrists operated on to relieve severe pain in wrists and hands (Carpal Tunnel Syndrome). "Great relief" says he. In the same hospital at the time, **Arthur Harvey**'s wife Ruth was undergoing a cataract operation. She is making a good recovery. Wally is still working for the Educational Council and was pleased that all four boys he interviewed this year were accepted by M.I.T.

A note from Assistant Secretary Josh Crosby sends news from Millie and **Herb Kaufmann** that Millie was recovering nicely from her mid-winter bout with hepatitis and pneumonia. They have sold their house in Armonk, N.Y., and plan to live permanently in Sarasota, Fla. Josh also writes that he and Claudia will be spending a good part of the summer in Maine.

Sadly we report the deaths of four classmates: **Albert E. Bachmann** of Keystone Heights, Fla.; **G. Howard Le Fevre** of Boston, Mass.; **William R. Hainsworth** of Laguna Hills, Calif.; and **Joseph C. Morrell** of White Plains, N.Y. Of these, only Joe Morrell got to our last reunion. He was a loyal fund raiser for M.I.T., working on the Second Century Fund drive and for our 50th Reunion Gift. Al Bachmann and Howard Le Fevre both came to earlier reunions and Howard will be remembered as the hardy soul who braved the cold waters of Long Island Sound in early June. Mrs. Le Fevre wrote that Howard was keenly interested in *Technology Review* and avidly read and enjoyed the Class Notes. The sympathy of the Class is extended to their families.

Two new addresses received: **L. Willis Bugbee, Jr.,** 1329 Joliet St., Detroit, Mich. 48207; **Morris B. Hart,** 65 Cedar Ave., Apt. D-2, Long Branch, N.J. 07440.

Your Secretary and Assistant Secretaries wish you a good summer with little sunburn and no mosquito bites.—**Sumner Hayward,** Secretary, 224 Richards Rd., Ridgewood, N.J. 07450; **Josiah D. Crosby,** Assistant Secretary for Florida, 3310 Sheffield Cir., Sarasota, Fla., 33580; **Samuel E. Lunden,** Assistant Secretary for California, Lunden and Johnson, 453 South Spring St., Los Angeles, Calif. 90013

22

As your Secretary sits looking out on a beautiful, warm, sunny Buffalo day, ideal for golf, thoughts quickly project to the 50th Reunion in June and back to the 45th Reunion at the Wianno Club in 1967. We have lost a few wonderful classmates in the last five years and will acknowledge their valued friendship at a memorial service on Monday June 5.

Parke Appel forwarded the report of our latest loss, **Duncan Robertson Linsley,** who retired in 1960 as vice-chairman of the First Boston Corp. Dunc was a life member of the Corporation having given continuous and valued service to M.I.T. He was formerly governor of the New York group of the Investment Bankers Association of America and a member of the University, Church and Downtown Association clubs of New York. He is survived by his wife Julia Quaintance, a daughter Julia Williams Linsley and two grandchildren. He lived at Hill Farm Rd., near Bridgeport. Our sympathy is extended to his family and associates.

As you read these lines, our Reunion will be history and be properly recognized in our next notes. We acknowledge the work and planning of **Dale Spoor** and **Don Carpenter** during the last two years. And especially for the constant effort of President **Parke Appel** consisting of his "far beyond the call-of-duty" contribution of talent. We all thank them.

Madeline and Parke spent two months in Venice, Fla., and received as visitors Katherine and Dale Spoor, Mary and **Oscar Horovitz** and others. Louise and Don Carpenter came in through a rough Gulf sea to dock their beautiful power boat at the Venice Yacht Club. . . . They also saw **George Marvin** at his prize farm in Ft. Meyers and **Larcom Randall** at his condominium at Crescent Beach on Siesta Key. . . . **Ray Ellis** was there also. They called on **John Starkweather** and telephoned **Frank Kurtz** at Del Ray Beach during a cocktail party where he was entertaining **Bob Hallock, Ted Riegel, Frank Rickers, George Erickson, Harold Stanley, Roland Smith** and **Dale Spoor.** Parke will go back to the same apartment in Venice next year for February and March. . . . Dale Spoor received a good letter from our Taiwan classmate, **C. T. Chien** who regrets not joining us in June. His children are married and living in New York and New Jersey with nine grandchildren among them. Frank Kurtz was delighted to have a visit from **Dexter Shaw** and his wife so they decided to write to **Walter Saunders** in Maine to especially invite him to the Reunion. He accepted. . . . Our 50th Reunion Fund has been recognized and encouraged by F. Steele Blackall, III in memory of our classmate Fred. We appreciate this and other similar gifts to M.I.T. . . . **Larry Davis** hopes to spend as many days as possible at the 50th Reunion. We all remember the truck-load of bottled goodies which he shipped to us during an earlier reunion at Pine Orchard, Conn.

Gunnar Brun of Norway wrote expressing his appreciation of news from M.I.T. He and his wife travel through the Scandinavian countries and spend a large part of their year at a mountain cabin. They still live in Lillestrom, Norway. . . . **Larry Washington** wrote from Palo Alto assuring his attendance and proper costume. . . . **Everett W. Vilett** of Short Hills, N.J., spent some time this past winter at the Naples Beach Club and the Bellevue Biltmore in Florida. Janice and Ev were island hopping in the Caribbean in March but came home in time to pay the class bills promptly. . . . **Paul J. Choquette** of White Plains has been busy with his third son's wedding in Ohio and is considering moving to Rhode Island. They visited Europe in 1963 and toured California in 1967. . . . **Fran** and **Albert Sargent** wrote from the Caracas Hilton as they continued their journey to Granada, Antigua, Martinique, St. Thomas and San Juan.

Shepard Dudley of Essex Fells, N.J., noted with his reunion gift that he and his wife will be on hand in June. . . . **Charlie Comey** of Sun City, Ariz., is too busy to retire and hopes to be back in Boston with their 747 Jet service to greet the Class. . . . Major **H. Langdon Haltermann** of Middletown, R.I., is unable to participate in June but appreciates reports from the class members. . . . Dottie and **Abbott Johnson** are back in Muncie, Ind., shedding a few pounds on a diet of steak and grapefruit.

We will celebrate the 50th wedding anniversary of Katharine and **Horace McCurdy** on June 3. They were married right after graduation. Horace has always been in constant touch with M.I.T. and has been most generous in his support of the M.I.T. crew, the latest event being the christening of the "Katharine McCurdy" at the M.I.T. boathouse (*see page 85.*) . . . **Lachlan Mackenzie** of Sun City, Calif., is trying to get a red shirt and hopes to be with us. He will fly from Cambridge to Scotland after our reunion activities are over. . . . **Ray Miskelly** of Yarmouth Port, Mass., spent April in Spain and Portugal and will tell us about it in June. . . . **Stephen B. Neiley** of South Yarmouth, Mass., sent regards to everyone. Doctors advised him not to attend. . . . **Roy A. Stone** wrote from Clearwater, Fla., reminiscing on his record-breaking five-year reunion attendance. He is encouraging all of his classmate friends to come and even looked up a few on the way to Alaska last summer. . . . We have heard from **Irwin J. Smith, Jr.,** and his wife Madeleine of Loudonville, N.Y. They hope to be with us in June. . . . **A. G. Silverman** retired from the Department of Defense two years ago but is remaining in the D.C. area for the time being.

It now looks as though the day is too far along to play hookey at the Country Club, so we will chalk this up as another contribution to the Class of '22. The best of summers and good health to you all!—**Whitworth Ferguson,** Secretary, 333 Ellicott St., Buffalo, N.Y. 14203; **Oscar Horovitz,** Assistant Secretary, 31 Montrose St., Newton, Mass. 02158

23

On April 19 **Herb Hayden** had another area meeting of the 50th Reunion Committee in New Jersey—attended by **Charles Mapes, Lem Tremaine, Clarence Chamberlin** and himself. The question as to what activities outside of the tentative program presented in the class letter of April 1972, was pursued. Should we have guided tours of the Institute; the same to historical points of interest; golf, bridge, swimming at the Marriott pool? The committee wants your ideas, so let Herb know your thinking (H.L. Hayden, 942 Main St., Lancaster, Mass., 01523). We now have a considerable head of steam working on this matter, including two meetings scheduled in Florida—one headed by **Rod Goetchius** from the East Coast and one from Clearwater headed by President **Ed Schmitz** (West Coast).

Now that Herb Hayden has some of the wanderlust out of his system we will see some real activity. We now have some data on his and Katie's trip to the Orient and South Pacific in 1971. He reports

51,000 miles and should you name a place, he and Katie have been there. . . . From **Scott V. E. Taylor** of Canoga Park, Calif., we have this cryptic statement, "My ship has not come in, but hopefully it is on its way; it is a tangible thing not still an idea." Tell us more Scott, we need the news! . . . From **D. G. Brinton Thompson** we learn, "Am still on the Executive Board of the Stowe Day Foundation, on the Publications Committee of the Connecticut Historical Society and am an officer in various patriotic and social societies, and a church vestryman."

This is a good month with no necrology and no address changes. *Technology Review* is still asking us to conserve space but we can use a little more if *you* will cooperate.—**Thomas E. Rounds,** Secretary-Treasurer, 4 Deer Hill Dr., Danbury, Conn. 06810

24

Your scribe was inspired to write these Notes shortly before the May 15 deadline by a big headline in the *Tech Talk* of May 10, "Klaus Liepmann Receives Gordon Billard Award." **Gordon Billard** in New York City is one of four classmates who has a great interest in music. Luis Ferre, Paul Tishman and Nat Schooler, among others, actively support this culture. It could well be that the grind of a technical education and business drove them to agree with William Congreve, "Music hath charms to soothe the savage breast, to soften rocks, to bend a knotted oak."

The Gordon Billard Award was established some years ago, not only for music, but as in Professor Liepmann's case, "for special service performed for the Institute." He will retire in June after 25 years as director of music during which he developed comprehensive programs with a strong undergraduate, faculty and community following. (*See page 83, this issue.*)

I have a letter from **Phil Blanchard,** designer and donor of our 45th name tags which indicates that he still is vice president of Wyatt, Inc., New Haven, Conn. Although he and his wife were in Florida during the First Fiesta, they could not attend but talked with Paul and Frank Shaw. Phil is all for an off-campus 50th, or "you would find a lot of wives missing." . . . **Paul Cardinal** manages to feed me news tid-bits, some good, and some not too good. **Paul Miller** and Helen teamed up with a bug for ten days only one day after returning from their Mexican sojourn. . . . **Gordon Harvey** and Clare had been back from Mexico only a week when he became hospitalized and is now at his home in Ft. Lauderdale walking, eating, watching TV and improving his speech.

Pret Littlefield and Peg left Naples April 21 to return to Norwalk, Conn. Their home had been burglarized during their Florida vacation, but it has been reported that their take from the Cardinals at bridge during the winter compensated somewhat. . . . Further news from Florida, **Boynton J. Fletcher** writes that he enjoyed the mini-reunion at Naples. Fletch is also proud that son, Charles P., was chosen by Alcoa and accepted by the Institute as an Alfred P. Sloan Fellow for the year 1972-73.

On a sad note, **Witter T. Cook** who had retired to Holmes Beach, Fla., in early 1971, passed away March 25, 1972. Doc will be remembered as the author of "The Hidden Idol," the Twenty-Sixth Annual Tech Show in 1924. Basically an electrical engineer, he was associate editor of *Voo Doo,* member of Masque, Scabbard and Blade, Radio and Aeronautical Societies. . . . We have also learned that **Harold Meier Benning** died of a circulation ailment on January 26, 1972 in Benton Harbor, Mich., where he was president of Saranac Machine Co., and three realty firms. He is survived by his widow and sons John and Walker, S.M. Sloan '63. . . . **Vincent K. Cates** passed away on March 14, 1972. At the time, he was living in Boston, Mass. We have scant information on his activities since 1949, but at one time he ran his own construction business, did some consulting and having a Navy commission, spent years with the Navy Department in the Bureau of Yards and Docks in Washington, D.C. and the Pacific. The Class is grieved by its loss and extends condolences to the families.

The International Executive Service Corps advises us that **Hartselle D. Kinsey** has completed his three-month assignment in Taipei, Taiwan advising on chemical engineering studies of chlorine and soda production. He is a retired vice president of Union Carbide Corp., and spent two years with us after Roanoke College (Salem, Va.,) collecting his master's. . . . In April, **Bill MacCallum** and Eleanore took up temporary residence in Brookline, Mass., for a change in scenery from Los Angeles. On their way, Eleanore was hospitalized at Kerrville, Texas, but New England clam broth is improving her health.

Another of academically distinguished members, **Hudson Hoagland,** was the Moderator on May 2 at Worcester Polytechnic Institute for a convocation on "Genetic Engineering—Man's Responsibility to his Future." Four honorary degrees were conferred. Dr. Hoagland came to the Institute with an A.B. from Columbia University and gained his S.M. in chemical engineering with us. He was the co-founder in 1944 of the Worcester Foundation for Experimental Biology. It has grown from a barn near the Clark University campus to a world renowned research institution employing 300 scientists and supporting staff. Its interests encompass cancer research, endocrinology, neurobehavior and reproductive behavior. The "Pill" is a direct result of work at the Foundation. Dr. Hoagland has two honorary doctorates and has been president of the American Academy of Arts and Sciences (three years) and the Society of Biological Psychiatry. At times, he has been associated with Harvard, Cambridge University, Clark University, Tufts and the Worcester State Hospital.

William H. (Bill) VanDusen sends his Alumni Fund envelope from Easton, Md., dated in April and reports spending two months with his daughter and family in Rhodesia. He also spent two months cruising in the Indian Ocean and South Africa. He notes "The reports of trouble in Rhodesia were, as usual, greatly exaggerated." Another *faux pas* of the news media?

Ed Moll, our dedicated Class President, has been working closely with the Institute to coordinate the purpose of our 50th Reunion Gift and the *modus operandi* of the new Environmental Research Program. As in all new ventures, the simple goal develops complicated situations. A screening media known as the "Interdisciplinary Environmental Council" has been established and will work closely with the newly created M.I.T. Environmental Laboratory. We, as the Class, are a very important cog in the financial gear. To make this most productive we will harmonize our efforts with Vincent A. Fulmer, Vice President and Secretary of the Institute, especially in industry contacts.—**Russell W. Ambach,** Secretary, 135 Aspinwall Ave., Brookline, Mass. 02146

25

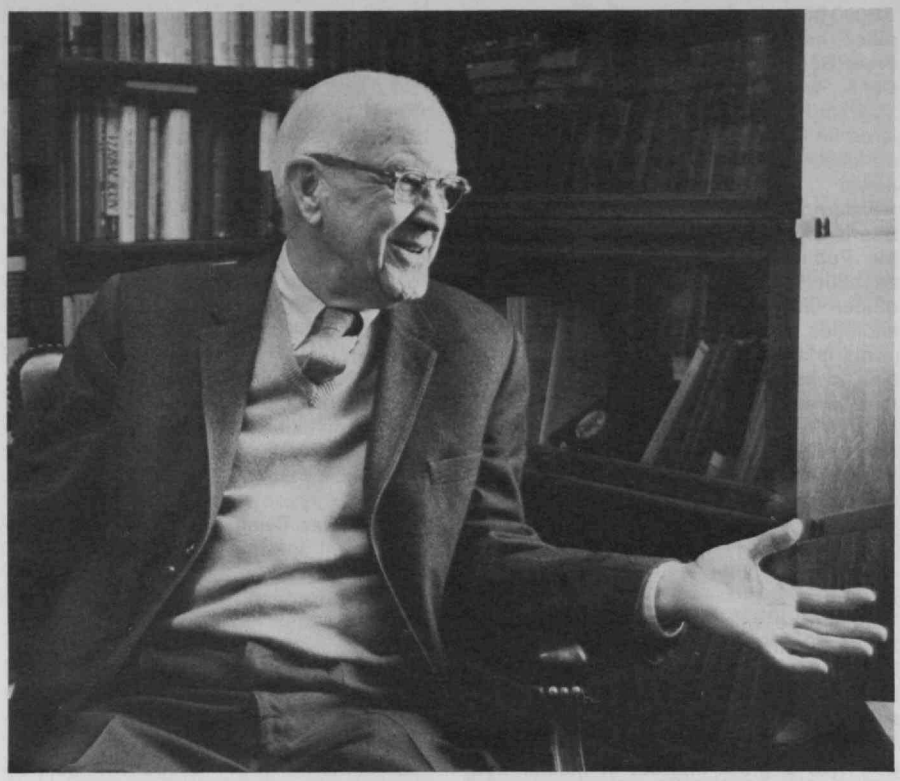
Yu Haiu Ku of Philadelphia has been the recipient of the Lamme Medal from the I.E.E.E. in recognition of his outstanding contributions to analysis of the transient behavior of AC machines and systems.

Last summer **Hollis Ware** retired from I.T.T. Arctic Services in N.J. after working with them and a sister company, Federal Electric Corp., from 1958. His final position was Supervisor, Compensation. He is looking forward to doing some occasional consulting work in this field. Hollis married Charlotte Campbell and they have two children, Colin, M.I.T. '53, and Martha who is married to Horton Shaw, M.I.T. '49. They have eight grandchildren and two great-grandchildren. Apparently the list of Ware relatives that have M.I.T. connections is numerous. Hollis, as a former Class Secretary must have realized my thirsting for a newsy letter, to him my thanks.

More thanks to Hollis and also to Sam Spicer for clippings from the *New York Times* dated April 24, 1972 covering honors received by **James** (Jim) **L. Clifford** just prior to his retirement from Columbia University. "18th Century Specialists Honor Resident Mentor" reads the heading of the article. Jim Clifford is now 71 years old and will be retiring this semester after 26 years. To honor him some of his former students, now specialists in his beloved 18th century, flew in recently from teaching posts around the country and presented him with a Festschrift of essays in tribute—now familiarly called the "Jimschrift." Fourteen of the 15 former students are now university professors of English and the essays deal with a range of 18th century letters. "The Jimschrift proves Jim Clifford's transmitting power as a scholar and as the cause of scholarship in others," said James M. Osborn of Yale. Jim received an engineering degree from M.I.T. and calculated that, while there, he attended the theater, an opera or a concert once every 2.91 days. He went to work for a company making railroad cars and it was not until the thirties that he discovered the true

faith. "Almost by chance," he said, "I read Boswell's life of Johnson and I never recovered." At Columbia Professor Clifford wrote his Ph.D. thesis on Mrs. Thrale with whose family Samuel Johnson lived the last 18 years of his life. In 1940 Professor Clifford founded the *Johnsonian News Letter.* When the rate for this publication was increased from $2 to $2.50 he blamed inflation but used Johnson as a lexicographer to define the term as "the state of being swelled with wind; flatulence." Not that Jim feels that the *JNL* is becoming swelled with wind but rather the world has become flatulent and that our money will not go as far as in the past.

I am sorry to report the passing of **Tse Tsok Choy** of Honolulu, on March 29, 1972. A native of mainland China, Mr. Tse was 79 at the time of his death. After graduation from M.I.T. he was initially engaged in electrical engineering in Honolulu. He later became president and manager of Wing Wo Tai and Co., distributors of fine Chinese silks, teakwood, cantonware and other products. In 1926, he invented and patented the original electrical device for powering the steel guitar; unfortunately, however, the manufacturing rights were confiscated by a company who altered his invention and filed for a separate patent. Mr. Tse leaves 7 children, 18 grandchildren and 3 great-grandchildren.—**E. Willard Gardiner,** Secretary, 53 Foster St., Cambridge, Mass. 02138



Retiring this year after 62 years at Columbia University, Professor James L. Clifford, '25, was honored by his former students—now specialists in 18th century letters—who flew in from universities around the country to present him with a Festschrift of essays in tribute dealing with Professor Clifford's beloved topic—the 18th century.

26

When Ruth and I take a little trip to a part of the U.S.A. we have never visited I usually study the Alumni Register to see what '26 men we can contact en route. We decided to see some of the South Carolina and Georgia coast. We flew to Atlanta where there are about 150 M.I.T. graduates but not one from '26. Another flight took us to Savannah where there still is no '26 man and in the whole state of Georgia there are only three: **Lawson Peakes,** an old friend and professor at Mt. Berry, **Ray Hudson,** who used to walk the path from the North Station to M.I.T. with us, listed as manager of a rubber factory at Dawson, Ga., and **W. H. Dargan** (who was a graduate student) in Athens, Ga.

In the whole state of South Carolina, there is but one '26 man listed, a geologist named **Joseph Lindsay** at Clemson College. It turned out to be such a delightful area that it is strange none of us have settled there. I recall that Sea Island, Ga., was one of Guy Frisbie's favorite haunts. In our short visit here's what the South Carolina-Georgia coast seems to have going for it. First it appears "undiscovered"—not the tremendous crowds of Florida. The climate is mild but there is a short dormant season to break the monotony. The beaches are miles in length with all kinds of birds and shells. The area is a golfer's heaven and as for yachting, a protected inland waterway runs the length of both states. This wasn't meant to be a personal travelogue, however, since most of our correspondence these days seems to be about retirement and no one mentioned either visiting or settling in this area it was tempting to mention it.

Having referred to retirement there are several news items that touch on the subject starting with the *Niagara Falls Gazette,* "**Bill Latham,** that big, quiet-spoken man with the cold-rolled steel temperament, is retiring. He has been the local 'Mr. State Power Authority' since it began its monumental construction project. During the hectic construction years and since, he has earned the respect and affection of Niagarans by his absolute command of his job and his devoted service to many community enterprises. Fortunately for us, Mr. Latham is going to remain a Niagaran in retirement, so we can continue to have the pleasure of his company and the benefit of his good works."

We have a note from **Stew Perry** which states that he retired from Worthington Corp., after 40 years of service as a sales engineer. . . . Another note from **George Cohen** says that he is retired and building doll houses and visiting his son in San Francisco, a Tech grad and a doctor and associate professor at San Francisco Medical Center. . . . And on the back of one of those nice business reply cards, **Charlie Snow** says: "Now semi-retired but still carrying on investment counsel work. Greatly enjoyed 45th reunion. . . . On a similar card **Bill Dixon** replies, "Retired but more active than ever in church and community plus golf. Spend the summers in East Boothbay, Maine. I am enjoying excellent health." . . . Finally, a stubborn engineer from San Antonio writes that he will never retire. **Martin Staley** writes us, "Greetings to Pigeon Cove from the city of the Alamo. I am still 'self-employed'—keep my office busy and myself on the job, more and longer than my help. That's the way I like it."

We seem to have met our Sunday morning deadline of finishing the notes by 9:30 a.m. with just time to say Cheerio—**George Warren Smith,** Secretary, P.O. Box 506, Pigeon Cove, Mass. 01966

27

Ezra Stevens has received word from **Amund Enger** that he is building a winter home in Algarve, on the South Coast of Portugal. Amund remarks, "Since the Portuguese are not in the habit of riding off the same day they saddle the horse—or the same month even—this has met with considerable delay—we could write a book."

In May, Ann and **Joe Harris** visited Amund and Frances Enger at their home outside Geneva, Switzerland. Joe writes, "They were the soul of hospitality. Amund maintains a living interest in classmates and friends of 1927. He has retired from day-to-day business but works closely with his partner in his ammunition business in Sweden. He is a very ardent golfer (as is Fran) and a prize-winning rifle shot, competing in the local Swiss matches." Joe adds that they saw the usual sights—Matterhorn, Jungfrau, the lakes—and were leaving Zurich for Northern Italy before returning in time for the Reunion.

Phil Darling reports from Houston that he is in process of retiring from the "no traveling, no management" job that sent him to Venezuela for a month last year and two months this year as assistant general manager, "so that Dora can do the bossing and I can get back to the quiet of Doran Co., a one-man outfit so named because you can pronounce 'Darling' in only one language. Doran Co. had previously been devoted to making mathematical models for computer programs where others had failed, and will now (I hope) be largely devoted to my retirement hobby, photography."

In the March-April notes, Joe Harris mentioned that **Ed Dunn,** who lived so long in Hartsdale, N. Y., had moved to Wilmington, Del. Now we have learned that the move involved Ed's marriage, after all these years of bachelorhood. No details yet, but on behalf of the class, we wish him and his bride all happiness.

While the rest of us are traveling longer or shorter distances to arrive at the Reunion, **Brad Gerrish** will just be crossing the bay. He bought a year-round house in Melvin Village in 1971—one unit of a four-unit town-house condominium. He is still dividing his time between Melvin Village and Melrose, Mass., where he is a part-time consultant to Diamond International Corp. and Columbia Precision Industries.

The following brief notes are from **Dike Arnold:** "While enjoying my annual vacation at Boca Raton this winter, I ran into **Dal Sparre,** who was at the hotel attending a convention. He is still working, is well and happy, and is hoping to make it to the reunion. I also had a brief visit with **Rene Paine** while in Boca. He lives in Fort Lauderdale and plays a lot of golf. Saw **Jack Boyle** at the M.I.T. Club of Boston last week. Unfortunately, his wife has not been well, and he can't make the reunion."

A recent article in *Spaceflight* on **John P. Vinti** reports that he and his colleague, Leonard Wilk, have recently completed an analysis of an experimental method for determining the gravitational constant G in a large manned orbiting laboratory. Along more immediately practical lines, the Measurement Systems Laboratory is now looking into the uses of satellites for various surveys, such as traffic control, geodetic, and oceanography. Dr. Vinti expects that the "fantastic" requirement of 10 cm. accuracy in mean ocean level may soon be met on the instrumental side.

We sadly report the death on April 11 of **Paul S. Vaughan.** He had retired as manager of engineering development and products engineering for Alco Products, Inc. after a distinguished career marked by pioneering work and a number of patents on locomotive and other engines. Paul's life was distinguished beyond his engineering accomplishments. These words are from the letter written by his wife, Helen, announcing his death: "Paul was truly an unusual man. His patience and fortitude never wavered during his long illness, and he never lost his sweetness and gratitude for the good things life had brought him. I feel sure he had to come to grips with himself about what he probably understood was coming, but he was most philosophical and accepting of his fate. Towards the end, he was very weak and not talking very much, but the morning he died, we enjoyed a joke together. We had thirty-seven wonderful years together."

The following address changes are reported by the alumni office: Harlan R. Allard, 13 Ladd St., Watertown, Mass.; Professor Harriet W. Allen, P. O. Box 50471, New Orleans, La.; Ole F. Christiansen, Box 5046, Grove City, Fla.; Chester A. English, 461 N. E. Ave., Pompano Beach, Fla.; Herbert M. Houghton, 3428 Foresst, Medford, Ore.; Professor Lloyd A. Bingham, South Hero, Vt.; Elwood A. Church, 2 Mansion Rd., Marblehead, Mass.; Richard Cutts, Jr., 21 Lombardy Lane, West Warwick, R. I.; Louis F. Eaton, 19 Chapel St., Duxbury, Mass.; Dr. Frank G. Kear, 3913 Leland St., Chevy Chase, Md.; David R. Knox, 10474 Lincoln Dr., Huntington Woods, Mich. Dave Knox has a winter address in Lake Worth, Fla. Howard Ferguson's Florida address, previously noted, is for the winter only; the rest of the year, he is at 470 Stepp Ave., Hendersonville, N.C.—**Joseph H. Melhado,** Secretary, 24 Rodney Road, Scarsdale, N.Y. 10583

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As usual, with the coming of warm weather class correspondence has just about ceased. Most of us have other things to do now and this is quite understandable. We do have a few notes, mostly relative to classmates in and near Boston. . . . **Ben Draper** says that he has no present plan to retire. He hopes to work just as long as he is serviceable. Draper Brothers Co., in Canton, Mass., has been Ben's whole interest since graduation. Under his guidance the company and its products have seen important technological advances. Its paper mill felts, made of wool, each one "built" for a specific machine, have long been recognized nationally for high quality. The company also produces knitwear and high pile fabrics for lining stock.

At the time of this writing (mid-May) **Dave Mathoff** was recuperating from another four-week stay at the hospital. He was looking forward to the warm weather and then to attending the reunion next spring. . . . **Bob Proctor,** who retired from business last fall, reports he is now busier than ever. He has done consulting work, engaged in some civic service activity, and has made a start toward a teaching career. His son Tom was about to graduate from State College at Lowell, Mass., in June and the Proctor families were gathering from all parts of the country for a grand reunion. . . . **Bill Hurst,** writing in his own vigorous manner, has expressed his views on trends at the Institute. He favors return to a strong emphasis on science and technology and much less on the trend toward liberal education. . . . With much enthusiasm **Herb Swartz** reported that everything was coming vigorously to life at his New Hampshire fruit farm. The apple trees were showing promise of a heavy bloom with indication of a good crop yield. In addition to his orchard Herb has about 100 acres in native blueberries. This gives employment to the local young people during picking season. Both birds and deer are part of the problems of a fruit grower. Beavers also keep Herb busy. The critters insist on adding to the height of the cement spillway of the pond dam. The rising waters then overflow and erode the earth dam.

It is not a bit too soon to start your plans for attending the 45th class reunion next spring. As a first step you can mark your 1973 calendar reserving the dates June 1, 2, 3, and 4. As most of you know already, we have engaged the facilities of the Bald Peak Colony Club at Melvin Village, N.H., for that entire weekend. This is a magnificent place, situated on the upper shores of Lake Winnipesaukee and surrounded by beautiful New England countryside. Here there is everything for the best of vacation enjoyment. Those who know this spot and have stayed here speak of it only with enthusiasm. It is a great privilege for us to have come this far in time as a Class and you'll not want to miss this important event. We expect to be mailing first informational material in the fall.—**Walter J. Smith,** Secretary, 209 Waverly St., Arlington, Mass. 02174

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I regret to announce the death of **Henry R. Childs,** Course X-A, of Kingsport, Tenn., on October 18, 1971. No details are available at this time.

Frédéric A. Celler, member of the Board of Directors of the American Chamber of Commerce in France, and President of AMP de France, has been awarded the title "Officier dans l'Ordre National du Merite" by the French government. Fred has been enjoying playing golf at his club (St. Cloud) all winter. Fred attended our 40th Reunion at the Wianno Club with his wife.

Malcolm M. Hubbard of Newton, Mass., in his efforts towards physical fitness has been traveling by bicycle from his home to his duties at M.I.T. and has logged over 20,000 miles to date. In April, Mal took an eight-day trip to London to join his wife Elizabeth who was visiting relatives and friends. . . . **William W. Young** of New Haven, Conn., has retired and is enjoying his leisure. "Nothing much new with us," he continues in his note, "but how is my good old friend **Hugh Hamilton?**" . . . **Edward E. Reigle** of Midland, Texas, President of Farley Machine Works Co. of Wichita, Kan., and owner of Richmond Drilling Co. of Midland, Texas, writes, "In 1970, we toured Europe, visiting Ireland and Istanbul but concentrating on the Balkan countries. In 1971, we attended the convention of the Society of Petroleum Engineers, division of A.I.E.M. in Anchorage, Alaska and enjoyed a tour of the Prudhoe Bay oil development. In 1972, we booked a tour of the Orient which included a joint meeting of A.I.M.E. and M.M.I.J. of Japan. I am 66 years old today and I don't feel a day older than 70."

Hyman J. Fine of Norfolk, Va., Chief of Water Resources and Planning Division of the U.S. Army Corps of Engineers, re-

ceived an Outstanding Service Award recently. He was also made a life member of A.S.C.E. . . . Professor **C. Fayette Taylor** of Brookline, Mass., had a one-man show of sculpture last winter at the Naples (Fla.) Art Gallery where a number of alumni attended. . . . Word from Florence, wife of **Ivar T. Malmstrom** of Needham, Mass., reports that Ted underwent a hernia operation last October which slowed him down a little. Florence also had a disc operation in November, and by the end of January, she was able to drive her car around Needham. The Malmstroms have one daughter living in Needham with three children while her husband is in South Vietnam, and a younger daughter in Denver, Colo., expecting her second child. "Sorry to have missed the dinner meeting at the Faculty Club last fall," continues Florence, "but things are beginning to look up and we will join you in the spring."

While **Frank Mead** and his wife Mary were in Orlando in February, they contacted **Brig Allen** who had recently been hospitalized and was home recuperating. They had dinner with Evelyn Allen who is in good health. . . . **Hunter Rouse,** Dean of the College of Engineering, University of Iowa, writes, "Thanks for the good wishes (birthday). You have hit upon a fine way of keeping your column filled. I have resigned the Deanship as of last summer. Hope to spend next years travelling and lecturing. Doi and I spent a week on Kauai (Hawaii) in February, then tripped over a suitcase my first day home and broke two ribs. Old age creeps up in strange ways." . . . **Larry Hamlin** of Cos Cob, Conn., writes, "I am still pursuing my second career of teaching mathematics at Norfolk State Technical College and I expect to continue for a year or two more. Meanwhile, I am watching to see what you fellows are doing, so I'll be sure to go to the right place and do the right thing when I retire."

Charles B. Bacon of Middletown, Conn., President of Bacon Bros. Inc., is still active in his family-owned firm. He writes, "Four of our children and their families live nearby, and the other two are rather far away. Two of my boys are associated with my business, one of whom (Bill) is another Course II graduate, M.I.T. '57." In addition to his business activities, he is a director of Middletown Savings Bonds, Chairman of the Water and Sewer Commission of the City of Middleton and a member of the Rotary Club since 1938. . . . **Harold F. Nash** of West Simsbury, Conn., retired recently and is slowly getting into a schedule of some golf, gardening, travel and working around the house. . . . **Elizabeth M. Stefani,** of Provincetown, Mass., writes, "I am living here quietly with two of my sons who are in business partnership with me, remodeling and rebuilding houses. The oldest son, Robert is still single and is a social worker in New York City. My daughter Ann is living in West Hartford where her husband teaches. Some time ago, I tried for the Peace Corps, passed the physical, but then the funds ran out."

Albert Harris of Brookline, Mass. is semi-retired. He had been an Instructor in accounting at the Chamberlain Junior College in Boston. He does part-time work for H and R Block. . . . **Erling S. Mathiesen** of Wauwatosa, Wis., writes, "I was with Cutler and Hammer all my working years and was vice president in charge of manufacturing when I took early retirement in 1967. Alice and I enjoy retirement life greatly. We elected to stay in the Milwaukee area where our roots are many and deep. We play bridge, pocket billiards and participate in many social activities. I do some consulting and portfolio management."

Edwin H. Perkins of Ipswich, Mass., writes, "I retired in June 1971 after 41 years of service with the Bell Telephone Labs where I was associated with the design of carrier telephone systems. Much of the time was spent designing feedback amplifiers, starting in the 1930s with the original concepts of feedback. I have been active in the Air Force Reserve since M.I.T. days, served four years in World War II, and retired as lieutenant colonel in 1966. My daughter was graduated from B.U. in 1966, is now married and living in Boston. My son graduated from Occidental in 1970 with an R.O.T.C. commission in the Air Force Reserve and is now on active duty. My wife and I are living at the shore in Ipswich. I am active in boating and have a 26-ft. sloop, and I am currently Commander of the Merrimack River Power Squadron of the U.S. Power Squadrons."

William J. Degnen of Westfield, N.J., took early retirement in 1967 from M. W. Kellog Co. and has been a part-time consultant with the firm. In 1971 he was appointed a full-time consultant to E.T.A. Pullman, S.O., subsidiary of Pullman Inc., performing engineering services in Mexico City for M. W. Kellog.

Frederick Metcalf Thomas of Old Mystic, Conn., writes "My current technical interests are yachts, solar heating and soaring, of which I have done a great deal in the last two years. My gliding interest was stimulated at M.I.T. during the winter of 1927-28, when a dozen of us built a primary glider. Another graduate student, James M. Shoemaker, (not to be confused with J.M.S. of the Navy) a brilliant guy, now dead, was the center of this activity. It was flown at Wellfleet in the summer, first by Ben Kelsoy and before it became my turn, it cracked up on the third flight. M.I.T. pilots that I have talked to since do not seem to remember this episode. It wasn't until 1938 that I was shot off a cliff in a primary at Dunstable Downs. Then followed a lay-off of this activity for the next 31 years. I am a member of N.E.S.A. and also fly out of Plymouth, although my glider has been kept in Springfield the past year. I am not a competition pilot, but one who flies for fun, 8 types, and coming up for my commercial in the newly built ATC'd Blanik in a week or two."

Charles W. Sampson, Rochester, N.Y., writes, "Retired in May, 1969. Spend two days a week in helping out a tool company, by making side contacts for them. It has been a nice way to keep myself busy and keep in touch with people with whom I did business in the past. We are also kept busy visiting our children and grandchildren, 60 and 220 miles apart."

A "newsy" letter comes from **Frank O. Pierson,** of Cromwell, Conn., "Life in a florist business is quite hectic. The number of failings are increasing, both in the growing and in the selling of cut flowers. However, it does seem that the worst is over. I am still planning to retire this fall; before I reach 70 next spring. We plan to buy a 31 ft. travel trailer, accommodating two people. Then we plan to tour the South and Southwest, playing a few rounds of golf at various courses. Next summer, we may play the Northern courses which are so popular. We are members on leave of absence from Westchester Country Club and we hope to rejoin, possibly as a non-resident. So far in our travels, we have not seen any course we like better than Westchester.

"In between golf, we hope to get in some other sports. I enjoy scuba diving and my wife Florence enjoys snorkeling. While on the move, we may find just the place to settle down. We both have worked hard and long hours for many years, so we want to catch up on a lot of playing we have missed."

Arnold W. Conti of Shrewsbury, Mass., is scheduled to retire this summer from his position as Chairman of the Board, Worcester County Institution for Savings, one of the largest savings banks in that area. "Though I hate to retire," he says in his note, "since I have reached the legal retirement age, I will have to step down to make room for younger executives who are anxious to climb up the ladder of success." Arnold enjoyed many years of a purely engineering career, in partnersip with **Paul Donahue,** under the name of Conti and Donahue, General Contractors. Then he shifted from engineering to finance and banking, landing on the top position, Chairman of the Board. He and his wife Mary, members of the 40th Reunion Committee and very active in Class and M.I.T. affairs, have two sons: the younger is a junior at Clark University, and the older one has a degree in psychology from Johns Hopkins and is currently involved with environmental engineering at Worcester Tech. Arnold has no definite plans for the immediate future, except to stay active in the field of finance. He has enough hobbies to keep him busy and "Mary's hobby" he says "seems to be to dream up projects for me to do." He lives near **Robert Pride** and his wife Marion with whom they have regular social contacts playing cards and other activities. He says that somehow, women always seem to win the money in card games.—**Karnig S. Dinjian,** Secretary, 6 Plaice Cove, Hampton, N.H. 03842

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Again this year there was a vernal surge of news from our classmates which presents me with the rarely encountered problem of deciding what to exclude. We have at hand a gratifyingly full report from **Joe Harrington** concerning both his own activities and those of a number of other members of the Class. From 1955 to 1970 Joe was head of the mechanical engineering department at A.D.L., engaged largely in designing automatic production machines and mechanical

products, as well as developing manufacturing systems and the management thereof. Much of his work in recent years has been in the field of numerically controlled machine tools. In mid-1970 he took early retirement and went into business for himself as a consultant. However, he still maintains an office at A.D.L. and spends a day or more a week on their work. The rest of his time is occupied by a variety of other clients. In recent years he has done quite a lot of expert witness work in the field of patent litigation (including a suit he won for a client of your secretary's firm). In his spare time he acts as Town Moderator of his home town of Wenham, does some springtime gardening and works on a book he is writing on "Computer Integrated Manufacturing."

Joe has also supplied us with news about **Jack Latham.** As many of you know, Jack has been interested for a number of years in the design and development of blood handling and blood processing equipment. He has recently formed the Haemonetics Corp., to manufacture equipment which will separate the blood plasma from the cells and wash the water content out of the cells so that they can be safely frozen at liquid nitrogen temperatures and preserved for many years. With this equipment blood can be taken from a donor, the plasma separated and used and the cells returned to the donor, thus making it possible for a donor safely to give a pint of blood every week or ten days as compared with the usual interval of about six months. This development could manifestly be of great importance in a major disaster area. . . . Joe also reports that **Reg Tarr** has retired from Mystic Valley Gas Co., and is active in the Wenham Housing Authority.

Charles (Chuck) Habley has retired from Lockheed where he was manager of market planning and research and is now a senior account executive with Putnam Financial Services in Los Altos, Calif. He is very enthusiastic about the changes at M.I.T. Since our graduation "M.I.T. is cognizant and "keeping up with the 'revolution' in higher education" in terms of "relevance to changing times" and acceptance of "social responsibilities." (In contrast with Chuck's comments, some months ago I received an adverse comment on these same changes phrased in language so intemperate it had to be censored.) . . . As previously reported in the Notes, **Frank Hankins** retired from Lockheed some years ago because of Parkinsonism. He was fortunate in being able to participate in the early test program with L-Dopa at New York Hospital and says that most of the symptoms of the disease have now disappeared. Thus he was able to play golf in Florida this winter. Frank served four years as mayor of Frankin Lakes, N.J.

This month I received what my records indicate is a first report from **Bill Harris.** From 1940 to the mid-1950s Bill was manufacturing vice president at American Bosch. Thereafter he was vice president of Saco Lowell until they moved south, at which time he retired. Bill's first wife died in 1960 and he has since remarried. He and his present wife apparently do considerable moving about. He says that their annual routine comprises: July in Maine, August on Cape Cod, September and October in Canada visiting his wife's relatives, and an extensive cruise in February and March. The cruise last year was to the South Seas and the prior year through the Greek islands. "Home" is Wellesley Hills.

Maurice (Yicka) Herbert has for many years operated the Franklin Paint Co., of which he is president and principal stockholder, in Franklin, Mass. He says that his business "has been steadily successful but not spectacular." He and Maryan take a European vacation each year. Yicka's main hobby is coin collecting, especially ancient coins. His oldest silver coin is an Aeginian stater minted about 700 B.C. The oldest gold coin in his collection is a Macedonian stater minted in 350 B.C. . . . Yicka says he often sees **Tom O'Conner** at the Charles River Country Club of which they are both members. . . . Also he saw **Jim Morton** at their high school reunion last year and Jim appears to be in good health and spirits. . . . From time to time he sees **Bev Ottoway** who works for the Massachusetts Department of Public Works.

William H. (Wanny) Wannamaker, Jr., reports that he retired last year but doesn't say from what. He still has an electronics laboratory in which he enjoys trying out new ideas.—**Gordon K. Lister,** Secretary, 530 Fifth Ave., New York, N.Y. 10036

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Howard L. Richardson, Class President, has sent the following announcement: "At our 40th it was suggested that we should plan a 42½-year reunion in Mexico City. The idea was received with great enthusiasm and 44 couples said they would like to attend. March 1973 is the date, and we are beginning to develop our plans.

"We are fortunate in that Polly Germeshausen has consented to be General Chairman for this special reunion. Everyone in '31 will be sent preliminary information soon. Plan to join us for a wonderful Mexican Fiesta weekend."—**Edwin S. Worden,** Secretary, 35 Minute Man Hill, Westport, Conn. 06880

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F. Rolf Morral writes that on reaching 65 in June he is being retired from Battelle. He and his wife Lillie, are moving to Barcelona, Spain where he will be associated with the University of Barcelona assisting the Instituto Tecnologico Metalurgico "Emilio Jimeno." We wish them a gracious new life.

Thomas A. Lane who retired as Major General from the U.S. Army to become a syndicated newspaper columnist and lecturer is now the author of four books: *The Leadership of President Kennedy, The War for the World, Cry Peace—the Kennedy Years,* and *America on Trial—the War in Vietnam.*

Stan Johnson writes that in November 1970 he was offered and accepted an appointment as Town Engineer of Harrison, N.Y., and has been boiling in the political cauldron ever since. He indicates it is quite a change from private employment. He is still very active in yacht racing and manages to squeeze in an occasional game of golf. . . . **Frederick E. Mader** has the new title of Technical Field Representative attached to the New England office in Boston of the Insurance Services Office. From 1961 to the closing of the Worcester office in 1970 he was divisional manager of the I.S.O. previously known as the N.E. Insurance Rating Association.

Dr. **Harry Shwachman** has been promoted to Professor of Pediatrics at Childrens Hospital on the Faculty of Medicine at Harvard University. Dr. Shwachman recently relinquished his administrative responsibilities for the direction of the clinical laboratories of the Children's Hospital Medical Center to involve himself full time in all aspects of cystic fibrosis and nutritional disorders of infancy and childhood. He held administrative posts from 1946 to 1971 during which time he founded and developed the Chronic Nutrition Clinic and was an active participant in the teaching and patient care activities of the hospital's medical service and tumor therapy divisions.

We have received notice of the death of **Nathan Paris,** of Lexington, Mass., on January 9, 1972.

At the time of this writing the 40th Reunion is a month in the future and when you read this column it will be a month in the past. At the business session during the reunion a new slate of class officers will have been elected for what may well become the next ten years of class history. This Secretary has asked the nominating committee to provide a new class secretary to carry through that period. My reasons are that I will be semi-retiring this July and my wife and I feel a need for complete freedom from all obligations in order to plan the next transition from partial to total retirement.

The enthusiasm which has built up for the reunion is evidence of the sincere interest that classmates have in each other and I hope that the information we have passed on to you during the past ten years has contributed to this interest. It has been a pleasant task which I relinquish with regret. I urge you to continue to provide the new Secretary with news which will be of increasing interest to your classmates.—**Elwood W. Schafer,** Secretary, Room 13-2145 M.I.T., Cambridge, Mass. 02139

33

Well, fellas, this column might well act as the all-time low, since the faithful have ceased to be so. This time around I have received just one unsolicited message from the Class. On top of this, I have written or contacted by mail, 55 of our usually cooperative men: To 30 I sent a xerox copy of a *Wall Street Journal* write-up on M.I.T. To 25 more, I wrote my usual "help" postcard, as the need for

such was becoming evident. The *Journal* article could have been viewed as controversial by some. I received one acknowledgment of this mailing; a word of comment might have assuaged my whatsis. From the postcard help bit, I did a lot better, received five or six replies. I am extremely grateful to Bob Forbes, Dick Faldetta, Warren Daniels, Art Hungerford, and several others who replied to my appeal.

Bill Klee acknowledged the receipt of the *Journal* article and commented only lightly by agreeing that we were "frumpy", as stated, and is considering taking a doctor's degree in just that field. I had asked Bill how "Avalon" was coming along, and he allows that it is doing a good job for the customers, but badly for the stockholders. You will recall that Avalon is an unselfish project in Warren, Ohio, privately-owned by many public-spirited locals, who have financed this fine community country club for the use of the citizens, and open to the traveling public. Bill extends to all classmates traveling north or south in the winter months to stop in at the Klee residence in Hilton Head, S. C., a beautiful private community built around a fine golf course, with a couple of good hotels as part of the picture. Leona and I have visited there, and enjoyed every minute, stopping at the (former) Governor Hilton Hotel. Many thanks, Bill, and Yes, the 40th is just under one year away. (See notice below).

We had a phone call from our genial President, **Jim Turner,** a week or so before we left Florida. He and Edna were on a combo business and pleasure trip to "Lost Tree," a resort just north of Palm Beach. I don't remember who lost the tree, but the spot is known as a fine vacation spot for tired northerners. Jim just waited to say hello, which we both appreciated no end. Jim urged me to attend the Alumni Day festivities, for conference purposes, just as though I needed urging. Leona and I have attended, probably 20-odd consecutive such days, and we will continue.

One of our faithful classmates took a trip recently, but could not send me a card as he did not have my address. Notice! the excuse is not valid, as everyone must know that all us hot-shots have a permanent address at M.I.T.: the Alumni Association which will forward anything you send them addressed to me.

While headed for the check-in counter at my N.Y.C. hotel, I ran into **Guido Garbarino,** a busier man one tries not to find. We did get a chance to say hello, and then Guido had to take off for an important meeting, so neither of us had any spare time, as I had an important Angus small group meeting all that evening.

With little to serve up to the faithful in the way of news, I wish to continue to call your attention to the fact that our 40th Reunion is to be held next June (1973) at Chatham Bars Inn, probably June 3-4, 1973. For those of you who have not been paying attention, your officers have been working on it long since. The 40th Gift Fund is apparently running on schedule, as per Chairman **Ellis Littmann**. The success of this important reunion is already assured, but more than that, we want it to be an *outstanding* success. Please let me suggest again that you should be making plans to be there complete with wife, and maybe kids. Make those plans known to the Reunion Chairman, Westy Westaway. An overflow of attendees is not to be scoffed at, and Westy must know early if additional space will be needed. Westy's address is: **Clarence R. Westaway,** 40th Chairman, 247 Commonwealth Ave., Boston, Mass. 02116. Now don't go out of your way to find some other place to go, come June 1973.

That's it for July 1972. Next issue will appear in the fall.—**Warren J. Henderson,** Secretary, Fort Rock Farm, Exeter, N.H. 03833

34

Over the years, as far as our Class was concerned, to me Eastman Kodak always meant Phil Kron. So it was with real surprise that I read of the retirement of another classmate from that firm. In May **George R. Struck** stepped down from his position as assistant vice president of Kodak and general manager of the radiography markets division. George had joined Kodak in 1939 and spent his entire career in the radiography field starting in x-ray sales, he became assistant manager of the medical sales division in 1947 and manager in 1950. The area was renamed X-ray sales in 1961 and he continued as general manager. The company revised its marketing structure in 1964 and at that time George was appointed to the position he held when he retired. It was also in this year that he was elected as assistant vice president. In 1965 George received the Special Award of Honor from the American College of Radiography for his contributions in that field.

News of another retirement came from **G. Roy Fugal.** Dr. Fugal received his master's from M.I.T. in 1934 and then a Ph.D. from Yale in 1950. He has been with the General Electric Co., where, he was manager of the personnel executive department. Dr. Fugal adds in his note, "Just appointed to the President's Committee on the Employment of the Handicapped; have served continuously as chairman of a State Apprenticeship Council longer than any man in the U.S.; and have just been awarded an honorary Sc.D. by Brigham Young University."

The death of **Wilbur R. Nordos** has already been reported and I have recently found some information concerning his career. At the time of his death he headed the New York State Education's Division of Intercultural Relations. Mr. Nordos had taught some 25 years in the New York City school system and in 1967 joined the State Education Department where his work was closely involved in integration problems in many communities. He played a major role in the settlement of the 1968 school strike over the experimental district in the Ocean Hill-Brownsville district of Brooklyn. He is survived by his widow and three daughters.

I have a note from **Sidney A. Whitt** who has been appointed Acting Dean of the School of Environmental and Resource Engineering, Syracuse University College of Forestry. He writes, "I was in classes with many M.E. students during 1933 and 1934, when I held a Tau Beta Pi fellowship at M.I.T., but I did not receive my master's until 1937. However, my classmates are all of 1934." He went on to get a doctorate in engineering science from N.Y.U., and has had a career in both business and teaching. He was chief design engineer for Fedders Manufacturing Co., assistant to the president of Baker Corp., and vice president and director of engineering for Cordley and Hayes. Before coming to Syracuse University he was head of the industrial engineering department at Montana State University.

S. A. Whitt, '34

G. R. Struck, '34

It appears that along the line **John W. King** took enough time from his real estate business to write a book which was successful enough to warrant reprinting. His *Save Money and Grow Rich* was published originally by Lyle Stuart and has now been reissued by Castle Books. There is now a copy in the M.I.T. collection in the library and, while it may be a little late to do us much good, it sounds like a fine title for our children. More to the point for us is another volume John is working on tentatively, "One Hundred and Three Ways to Grow Younger." . . . **Irving Kusinitz** writes, "I have made several trips to Venezuela during the past year, in connection with a new plant in Caqua. The plant went on stream during the week of March 6, 1972. It's a beautiful country and Caracas appears to be the fastest growing city in the world."

I have another episode in the round-the-world travels of Mary Elizabeth and **George Bull.** When last we saw our intrepid travellers they were in Teheran. Now we will pick up on George's story, "Here I am (April 15) in the Istanbul Hilton. At the moment that representative of noble proletarian poverty, the President of the U.S.S.R., Mr. Podgorny, is staying here briefly. Durir.g the flight from Teheran to Ankara we saw Mt. Ararat very clearly to the north of our flight path. No, I did not see Noah's Ark! The tomb of Ataturk is impressively located on a hill and is partially surrounded by porticos like Greek colonnades that turn out in part to be a museum housing various of his possessions.

"Western Turkey with the impressive Greco-Roman ruins is interesting. In Pergamon there was a Roman health center where, on the way to the baths, the patients had to walk down a tunnel and

attendants would whisper down through holes in the roof, such encouragement as 'The oracle says you will get well.' Years before Emile Coue! The ruins at Ephasus are the ones most excavated and probably the most interesting. The theatre is where St. Paul preached and was then run out of town because his talk about an unseen God was bad for the business of Demetrius and the other idol merchants who were cleaning up, selling idols of Diana. Her temple there was one of the Seven Wonders of the World but is now a complete ruin."

There is more in a final letter George mailed on his return in mid-May. But space is short so I'll save it for next time. —**Robert M. Franklin,** Secretary, Satucket Rd., Brewster, Mass. 02631; **George G. Bull,** Assistant Secretary, 4961 Allan Rd., Washington, D.C. 20016

35

The fall-out from the notes Doreen wrote for me in the April *Review* continue. **Jack Colby** writes from Islamorada, Fla., as follows: "Have been meaning to write you for some time and your lack of news in the latest *Review* put the finishing touches to my procrastination. We have had a really busy winter what with an unusual onslaught of visitors. Had a phone call one night from Venice, Fla., from **Dick del'Etoile** asking me to get him accommodations for two weeks. I was able to rent the efficiency right across the street. Dick's health has not been good but the two weeks here in the sun and water did him a world of good. He is in the process of disentangling himself from the three companies he has been running so that he can relax a little. His official residence is now Canaan, N.H. While Dick was here, who should drop in but **Lars Ekwurzel.** Lars, looking fat and happy, is now running his own advertising agency in Deerfield Beach, Fla., specializing in educational advertising. His home address is 1648 S. E. 6th St., Deerfield Beach, Fla.

"**Nix Dangel** was down here last year. Heard from **Al Greenlaw** at Christmas and he was still unemployed as the result of the Boeing S.S.T. layoff. He had some bitter words with regard to the cancellation of the S.S.T. and said that he was keeping busy cutting firewood off his property.

"As Chairman of a Committee to review our election procedure, I had the pleasure last year of having communication with Bob Forster, Wes Loomis, Stocky, Ham Dow, Ed Taubman, and Ned Collins. . . . Almost forgot to report on a great visit we had with **Jack Ballard.** He came all the way from Talent, Ore., where he has retired, to spend two weeks with us. Jack and I used to come down to the Keys fishing when we were both located in Milwaukee, so we had a real fishing reunion. Jack has turned into a real bird-watcher in addition to being a fisherman. He seems very happy in retirement and loves Oregon. Keep up the good work, Allan, and I will try and do better in the future." Many thanks, Jack, for the interesting news.

Ham Dow's wife, Edie sent me a get-well card with news of Ham's best round of golf. He did it after injuring a tendon in his leg on the first tee. I subsequently talked to her in Ham's absence on a recent California trip and learned that he made an 80. . . . I also talked to **Gerry Rich** and found that Rich Laboratories is beginning to feel the effects of the C.A.T.V. resurgence.

I have also received the following notes through the Alumni Fund office: **Barclay H. Bloomgarden** at Chestertown, Md., writes: "Lieutenant Colonel, Corps of Engineers, Retired; owner and operator Hybarc Equipment Co., still farming; wife Dorothy still in good shape after 36 years; number one son Barclay Jr., graduate of University of Maryland, C.P.A., runs own business, has wife Brenda, also a Maryland graduate, one daughter Gail, 5; number two son Michael—bachelor airplane pilot; daughter Dodds, married Bob Shamroth, Topsfield, Mass., expecting any day."

Walter Stockmayer writes from Dartmouth College: "Teaching, research, committee work, editing, and occasional meeting, etc. Preparing for the first coed class in Dartmouth history next fall. But I won't be here at that time—will be in Europe for four months, starting in July with a meeting in Finland and ending with about ten weeks in Limburg corner of Holland, taking a short sabbatical leave to do some research with a Dutch scientist-friend." At this point I would like to give special thanks to Stocky who has contributed material for these notes for three issues in a row. He is now leading candidate for the golden pen award.

John C. Alden writes from Concord, Mass., "Been working on an article on the B and M Snow Train 1931-71; should come out next winter." . . . **Alexander F. Hamilton,** long-time resident of Rochester, N.Y., and an employee of Eastman Kodak, reports that he is senior engineer in the Film Emulsion Coating Department. ". . . **Pat Guarino** reports from Rockville, Md.: "Spent two weeks in England last year as U.S. Chairman of (Quadripartite) Technical Cooperation Program committee meeting on Fuzes and Initiators. Next meeting in Canada in June 1972. Son David, Air Force Captain, stationed in Italy with his family."

Among the address changes is that of **John P. Bainbridge, Jr.,** who has moved to my old home town of Swampscott from New Canaan, Conn. . . . John lives at 11 Puritan Rd., about a mile from **Chet Bond** who lives at 423. . . . **W. Allen Taft, Jr.,** now lives on Cousens Island, Yarmouth, Maine, after moving from West Chester, Pa. . . . **Walter Godchaux** has moved to 45 Chapel Rd., Amherst, Mass., from New Orleans. Moves such as these each have a story behind them and I would very much like to hear from Mesdames Bainbridge, Godchaux and Taft.

There's plenty of activity on the home front, too: Doreen is a Director-in-Qualification for Mary Kay Cosmetics, Inc. Older daughter Pamela graduates from Newton High School this year and enters Colorado State University in September. Twin sons Peter and Chris have driving licenses (that makes five of us) and are getting paying jobs with their rock group which keeps them in gasoline. Melissa is finishing the fourth grade, and I am doing marketing consulting. I hope you are all having a fine summer.—**Allan Q. Mowatt,** Secretary, 61 Beaumont Ave., Newtonville, Mass. 02160

36

News is slim this month and these notes have had to be written prior to Alumni Day. I hope the lack of notes means that you have all contributed to the Alumni Fund long since. The result of telephone calls by members of the 40th gift committee revealed that **Frank Parker** has retired from Charles T. Main, Inc., and that **Herb Borden** uses his spare time for such things as arranging Ladies' Night at the Rotary International. . . . **Larry Kanters** has sent your Secretary a copy of his company's annual report. Larry is vice president for Department Stores of Gamble-Skogmo, Inc., with headquarters in Minneapolis.

We received late news of the death of **Sidney Cornell** in Reno, Nevada, on January 23, 1972. . . . The Alumni Office sent word also of the "assumed" death of **Charles W. Parce,** of Harlingen, Texas. If anyone has further information regarding these men your Secretary would appreciate hearing from you.

Now that a year has gone by since our 35th reunion I shall take this opportunity to remind you that the class officers are: President, **Tony Hittl;** Vice President, **Henry McGrath;** Treasurer, **Eli Grossman;** Reunion Gift Chairman, **Ed Dashefsky;** Class Agents, **Henry Lippitt** and **Elliott Robinson;** Class Estate Secretary, **Vin Estabrook** and last, but I hope not least—**Alice Kimball,** Secretary, 100 Memorial Dr., Apt. 8-6C, Cambridge, Mass. 02142 or P.O. Box 31, West Hartland, Conn. 06091

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By the time these notes are published our 35th class reunion will be history. The next *Review* should contain a full report on all the events. We expect a total attendance of approximately 90 class members and their wives. We hope you didn't miss it.

At a recent reunion committee meeting talked with **John Fellouris** who has just returned from a visit to Greece and who is very active in the contracting business in the New Bedford Area. Also **Curt Powell** and **John Nugent** were at the meeting. Both are still bachelors and looking young as ever. . . . **Les Klashman** has retired from E.P.H. and is very busy with consulting work on Water Supply and Water Pollution Control. . . . **Walt Wojtczak** was recovering from a recent cataract eye operation. He will be with us at our reunion. John Fellouris is playing tennis and figures he should have no trouble with Walt. Walt had a different opinion, even with the eye problem.

George Tapley has completed over four years service as Secretary of Sterling, Mass. Housing Authority. He also recently

A. Donald Moll, '43

received official notice from the Rotary Club of Brookline, Mass., of his perfect attendance for 30 consecutive years with Rotary International. . . . **Kenneth Bullington** recently published an article on "Unlocking the Secrets of Microwave Propagation." Ken is a radio consultant for Bell Laboratories at the Holmdel, N.J., location.—**Robert H. Thorson,** Secretary, 506 Riverside Ave., Medford, Mass. 02155; **Curtiss Powell,** Assistant Secretary, Rm 5-325, M.I.T., Cambridge, Mass. 02142; **Jerome Salny,** Assistant Secretary, Egbert Hill, Morristown, N.J.

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Last month I made the suggestion of attending a pre-convention reunion at the Mexican fiesta next March. On the brief mention it appears that about five or six are already planning to go. As far as the main 35th Reunion is concerned a group of us, including **Don Severance, Paul Black, Sol Kaufmann, Horace Homer** and myself met at Cambridge to discuss plans. Just as soon as we have a firm commitment on the meeting place we will alert you so that you can plan for attendance.—**A. L. Bruneau, Jr.,** Secretary, Hurdman and Cranstoun, Penney and Co., 140 Broadway, New York, N.Y. 10005

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At the M.I.T. Fiesta in Mexico in March 1972, those present from our Class were **George Kosco** and his wife Bernie and **Ken Lish.** . . . **Herb Hollomon** is the first director of the Center for Policy Alternatives at the Tech School of Engineering to foster the application of technology to the solution of social problems. He has also been appointed visiting professor of engineering. . . . **Dixon Speas** is coauthor of a paper delivered at the fourth conference on weather forecasting and analysis in Portland, Ore., on May 1, 1972. Dixon is founder and head of the R. Dixon Speas Associates which has been providing professional consulting services since 1951. The organization is headquartered in Manhasset, N.Y., and has branches in Georgia, Florida, California and Canada.

Isabel Rowe has spent two semesters with us taking free-hand drawing in the School of Architecture; it is noted that Tech is the college of her choice to send her pennies to since she admires it above all others. . . . **Bob Gould** writes: "We're still keeping the family flying machine hot. Son Bob's trying to out-fly the old man. While an architectural student at Kent State, he's picked up his commercial pilot's license and instrument rating. We both took up soaring a few years ago. With two pilots for one airplane, mother usually ends up as the back-seat driver."

Norm Klivans is a member of our growing list of consultants as shown by his letter: "A few lines to keep you informed about my activities. In the fall of 1970 I resigned from Gould Inc., after 20 years with Clevite and Gould. Spent a few months on 'withdrawal' and went to the South Pacific islands with my wife, Alice. In March 1971, I joined a management consultant group here in Cleveland, Aucter Associates. The organization includes many professors from Case-Western Reserve University, Cleveland State University, and other former industrial executives. We provide professional consulting services to companies in which there are some technical problems involving engineering, marketing, production, or business planning. During the first year and a half of operations we have done quite well. We now have clients from overseas, spread out around the U.S. and even some here in Cleveland. Our main thrust is to provide an improved technical base for industrial companies here in the northern Ohio region—and try to replicate on a reduced basis the route 128 conditions. Health is good. Now that I have a more flexible schedule my interest in the local Tech club has increased and it has been great fun becoming involved again with other Tech graduates."

May all of you have a pleasant summer and don't forget to write once in a while to keep this column breathing.—**Al Guttag,** Secretary, Cushman, Darby and Cushman, 1801 K St., N.W., Washington, D.C. 20006

41

Just a few items of interest this month for the Class of '41. We heard from M.I.T. and **Hank Avery** regarding his election as the successful candidate to the District 5 nomination. Hank also has been reappointed for a two-year period as Civilian Aide to the Secretary of the Army for Western Pennsylvania.

A news release from the United States Department of Commerce, announces that **Edith L. R. Corliss,** of the Institute's sound laboratories, has used the techniques of communication circuit theory and relations of conventional information theory to derive the channel capacity of the ear. . . . We heard that **Stanley Backer** has been elected Honorary Member of the American Society for Testing Materials.

Michael Driscoll was checking the Alumni Directory and was surprised to find we have nine M.I.T. alumni living permanently on Nantucket. We hope to get together and see if we can get an M.I.T. Club going here on the Island so that we can play host to other alumni who visit during the summer.—**Michael Driscoll,** Secretary, P.O. Box 1044, Nantucket, Mass. 02554

43

The avid readers of these columns have detected a variety of techniques being employed by your class secretary in his attempts to "extract news" this past year! One technique was the not-so-subtle plea for classmates to enlarge on the formal "PR-type" announcements when they were promoted to a new post in their company. Hurrah! the technique paid off, for in the mail today came a fine letter from **A. Donald Moll,** President of Minneapolis Electric Steel, a subsidiary of Evans Products Company. Your letter is great, Don, and if you put forth any more literary masterpieces like this, I'll figure you are bucking for my job! I've just put you on my "replacement table." Listen to Don Moll tell it like it is. "In July of 1970, Minneapolis Electric Steel Castings Company became a wholly owned subsidiary of Evans Products Company of Portland, Oregon. Last March, after sixteen years in marketing, I was promoted to Executive Vice President, and became President the first of the year. I am finding the broadened responsibilities of general management a lot of fun, and at present am involved in planning for increased growth in new markets, both geographical and by industry. We also have an imminent need

for expanded manufacturing facilities. We are a small company, with employment of about 300 at present, but have shown gratifying progress and have been successful throughout our history.

"My career in local politics appears over at least for the foreseeable future. I retired as Mayor of Roseville, Minnesota December 31 after completing a second two-year term. I ran unopposed for re-election, which is a testimonial to either general satisfaction with our administration or public apathy, I'm not really sure which. At any rate, it was a very rewarding and educational experience.

"Our family has grown up and departed the nest. Both daughters are married and living in the area. Nancy, our eldest, and her husband have a son, so we are enjoying the new experience as grandparents. Son Ken graduates from Carleton College, Northfield, Minnesota this year, and is contemplating graduate study in psychology.

"My recreational interests still are centered on fishing, skiing, and hunting. They have taken us afield from Minnesota in recent years. The most interesting new project we have under consideration is construction of a house at Chet Huntley's Big Sky development in Montana. We have progressed to the lot selection and down-payment stage, with construction contemplated this summer.

"All in all, the years have been kind. We have been fortunate enough to enjoy reasonably good health, acquire a lot of friends as well as a good family, and have had a lot of fun. Realizing that we have reached middle age is a little frightening, but when you consider the alternative, I'll settle. Best regards to all, and I'd look forward to a call from any old Tech friends who happen to be in the area."

As I write these notes, I'm off to Panama for the initial demonstration in Cristobal harbor of my company's SCAMP hull cleaning equipment on a large container ship of a major U.S.A. shipowner. It's a remote-controlled machine which operates under guidance from an adjacent work boat, traversing the underwater hull surface in broad sweeps, cleaning with an efficiency and thoroughness which cannot be matched by hand-held brushes and scrubbers. It's beautiful—and if you're in the marine operations field, please drop me a line! Happy summer holidays to all!—**Jack Kelly,** 34 Scudder Road, Westfield N.J. 07090

44

In case you did not realize it, I have the addresses of our classmates and would be glad to keep you posted on a change if you drop me a line. There is a great deal of change: in March I was notified of 12 changes of address and each was in a different state! One other brief notice: Leo Pach, Course II, '40 would like information concerning a member of our class who helped him with his thesis in refrigeration lab back in the fall of 1940. The helper reviewed film frame-by-frame and plotted points on a screen. If you are his man, please write to him at 28 Tudor Ct., Springfield, N.J. 07081.

Now let me continue with the alphabetical report I started last time. **Andrew Buccini, Bill Cooley** and **Paul Robinson** received 1971 Presidential Citations from the Alumni Association for their work on the D.C. Regional Conference and Area Fund Raising Council. . . . **F. A. Chenault** is Assistant Technical Director (Weapons Systems) and Head, Systems Development Department at the Naval Weapons Center, China Lake, Calif. 93555. . . . **Joseph Donahue** reports his daughter Martha entered M.I.T. last fall and is enjoying it (particularly the girls' sailing team and the R.O.T.C.). Joe is still practicing dentistry. . . . **John Embree** notes that he has sold his electronics company, Computer Dynamics, Inc. in Torrington and has moved to Teledyne Avionics in Charlottesville, Va. He participated in the design of an automatic take-off control system which is now operable in 750 of the KC-135 SAC aircraft. John is also 2/3 through his M.S. in environmental sciences at U. Va.

The *Bridgeport Post* carried a clipping concerning the promotion of **John B. Gardner** to senior vice president of the Kerite Co., a subsidiary of Harvey Hubbell. Kerite makes wire and cable. Prior to his promotion John was vice president —engineering. . . . And some lighter news: **Edward Jefferson** was married to Susan L. Boies of Naugatuck in October, 1971. Susan is a Smith girl. . . . **Mortimer Meyer** writes that his son Bob has entered Columbia Law School while Joe is at Western Reserve. Mort is on the Educational Council. . . . An article in the *ChemTech* for April 1971 (slight lag in the news) by **A. S. Michaels** concerns "Membrane Ultrafiltration." Dr. Michaels is president and founder of Pharmetrics in Palo Alto conducts R & D in the field of drug delivery systems. Pharmetrics, and the parent company, Amicon, which Michaels also founded, have revenues of $3 million. . . . On the other hand, **Arthur Peterson** has left the field and is enjoying his career in labor relations. He is in the New York school system with 21,000 students, 1,100 teachers, and 800 civil servants. He states that "they love me even if I'm not really educated."

Al Picardi's work has been featured in recent articles in *Building Design* and *Engineering News Record.* Al was responsible for the structural design of the fourth largest building, the Standard Oil (Ind.) building in Chicago. Besides a special tubular steel design, Al has developed a "Cost Risk Estimating Technique" using Monte Carlo methods.

Bernard Rabinowitz is multi-talented. He is in Democratic Party politics, the Mental Health Association and, on the side, is the owner of Atlantic Chemical Corp. in Nutley, makers of dyestuffs and organic intermediates. He is also president of Atlantic Western Ind. of Tempe, Ariz., maker of aerospace components. Bernie and Ann have four children: Daniel, Rebecca, Sarah, and John. . . . The W. R. Grace Co. announced the appointment of **Peter M. Rinaldo** of Briar Cliff Manor, N.Y., as staff vice president of the Chemical Group, where he will be responsible for planning and development programs. After graduation, Pete joined Dewey and

November's cover of Building Design and Construction *magazine featured E. Alfred Picardi, '44, and his work as a vice president of Perkins & Will, Architect-Engineers, and officer in charge of structural design for one of the world's tallest buildings—the 80-story Standard Oil of Indiana building in Chicago. As well as spearheading a number of construction breakthroughs, the building project introduces a vastly improved method of cost control through a new combination of the estimator's talents and computer probabilities, and cost savings by employing a tubular structural design which combines greater strength with much less steel.*

Almy Chemical, now a division of Grace and has moved up from vice president of Industrial Chemicals. . . . **Reggie Robba** is now president of Intelectron Corp. in New York City. Intelectron is engaged in the design and development of advanced medical electronic instruments. (Reggie, Bill Sadler, and I all attended M.I.T. from Webster, Mass.)

My faithful correspondent **Paul Robinson** reports that he received a call from **Robert Veitch** from Huntington, N.Y. Bob got a watch and a 25-year pin from Grumman Aerospace, Inc. last December. Paul is still in D.C., having moved over to the Marine Corps from the Navy. . . . The N.Y. State College of Agriculture and Life Sciences (Cornell) has announced that **Verne N. Rockcastle,** Professor of Science Education, received the Eva Gordon Award for Children's Literature in December. This is an annual award of the American Nature Study Society and is based upon Verne's Cornell Science leaflets, a quarterly publication for elementary schools. . . . **Will Rodemann** shook me up with his note regarding the length of time since our graduation. He lost his class ring while skiing in Austria and found that the new one he bought had sharp edges. He is vice president-marketing at Standard Register and President of the M.I.T. Club of Miami Valley.

A note from **Kenneth Scheid** (of Ken-

neth Scheid and Associates, Pittsburgh) reminded me that the column has not carried the news of the death on September 22, 1970, of **George Quisenberry** in Palo Alto. George is survived by his wife, Clara and children, Bruce and Ann. At the time of his death he was President, Packaging Dynamics, Inc.

Stanley Smock states that he became a "corporate drop-out" after 22 years in Dallas and started full-time ranching in the Colorado mountains. In addition to Angus cattle, the ranch has deer and elk and superb trout fishing. Stan, the rest of us are green with envy. . . . **Newton Teixeira** wrote that his family has reinforced its association with M.I.T. since he and his wife **Melissa** (**Wood** of 10-44) have a son Thomas enrolled in the Class of 1975. They brought all four children to our 25th reunion and he thinks that influenced Thom. . . . **William H. Tucker** (Bev to old friends) reports his oldest son is at Roanoke College, his daughter is at Ohio Wesleyan, and the younger sons at home may become M.I.T. engineers yet. Tucker Associates, electronic manufacturers' representatives, has survived the computer industry recession. . . . The **Walt Turner**s noted that their second daughter, Cathy, was named a presidential scholar. She was one of two to represent the state of Maine at the ceremonies in D.C. last June. Cathy is now at Wooster College (Ohio) and her older sister, Barbara, will attend the University of Glasgow next year.

The Gulf Oil Corp. announced that **Edward B. Walker,** President of Gulf Mineral Resources Co. in Denver, has been elected a vice president of Gulf Oil Corp. Ed joined Gulf's Venezuelan subsidiary, Mene Grande Oil, in 1947 and then went to London as exploration coordinator. In 1967 he returned to Mene Grande, first as vice president then president. . . . **Robert H. Wood** notes that his eldest three are now in college: Peter, graduating from Hamilton; Robert Jr., won his letter on the Colgate varsity hockey team; and Catherine finished her first year at University of Vermont. . . . Captain **John Woolston**'s news was short but to the point: In March 1971 he assumed command of the Charleston Naval Shipyard and is doing his best to improve it. That's it for this year, I think. But keep the notes coming.—**John G. Barmby,** Secretary, Systems Acquisition Division, General Accounting Office, Washington, D.C. 20548

47

The task of writing resumes for reunion must have been too much for most of you as the mail is very light this month.

The Cleveland paper had an article announcing that **Walt Ericsson** was promoted from assistant to the president, to division vice president and general manager of Arthur G. McKee's Iron and Steel division. . . . **Bob Creek** was re-elected to a third consecutive term as president of the local school board of trustees. . . . **Mrs. Philip (Penney) Wagley** has been elected to the board of trustees of the American University of Beirut. She will continue to reside in Baltimore. . . . **Bill Cullin** is now Professor of Engineering Management at Fort Belvoir. . . . **George Smith** has left his vice presidential position with Westinghouse Air Brake in Kentucky to become president and chief executive of Stowell Industries of Milwaukee. Drop us a line.—**Dick O'Donnell,** Secretary, 28516 Lincoln Rd., Bay Village, Ohio 44140

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Jim Adelstein was promoted to Professor of Radiology on the Faculty of Medicine at Harvard. Jim is also Director of the Divisions of Nuclear Medicine at the Peter Bent Brigham Hospital and Children's Hospital. The divisions have a combined teaching and research program using the tools of cellular biology, radiochemistry, and radiation biophysics to advance the use of radioisotopes in clinical diagnosis and therapy. Jim has been associated with the Faculty of Medicine at Harvard since 1958. He received the Ph.D. in biophysics in 1957 from M.I.T.

John Adams received two awards for his paper, "Rates Revenues, and Realism." Jim is president of Coffin and Richardson, Inc. of Boston, and specializes in utility rate setting. The Institution of Water Engineers of Great Britain and the New England Water Works Association made the awards to John. . . . **Harold Dutton** wrote from Mexico to wish us success and to help us achieve the megabuck gift to M.I.T. . . . **Perry Nies** is executive vice president of Foundee, Inc. in Casselberry, Fla. His firm manufactures safety devices, metal detectors, and communication equipment.

Leo Martin formed his own company on May 1, 1972. Martin Structural Plastics, Inc. will produce structural plastic foam. The company is based in Batavia, Ill., and will serve the Northern Midwest market. Purchase orders from former classmates will receive top priority. . . . **Ed Frohling** is president of Mountain State Engineers, the largest engineering firm in the Southwest. . . . **Karl Justin** became vice president of the New York City architectural office of John Carl Warnecke.—**S. Martin Billett,** Secretary, 16 Greenwood Ave., Barrington, R.I. 02806

49

Sad news this month, delayed from December 10, 1971, when **John J. Flynn** died, after a lingering two-year siege of cancer. Our heartfelt sympathy goes out to his wife and two sons.

On a happier note, **William Haddon, Jr.,** who appears frequently in this column, recently visited Australia where he gave the opening address and a subsequent paper at the National Road and Safety Symposium in Canberra. He also met with research workers and government officials concerned with reducing the energy damage to people and property occurring on the nation's roads.

Three notes from Alumni Fund envelopes end this brief column: **John Alger** reports that he has moved from Syracuse, N.Y., to Louisville, Ky. His new job is manager of operational planning for General Electric's airconditioning division. . . . **Donal Botway** reports that he has left Grumman Aerospace Corp., to become a partner and vice president of Roytran, Inc., New York City, manufacturers representatives, whose clients are primarily in the electrical and aerospace fields, with several being handled in conjunction with Allied International Corp. . . . **Pete Noss** reports that he is enjoying his new assignment as superintendent of process engineering at the San Francisco (Oleum) Refinery of Union Oil Co., of California. Pete's four sons are all now taller than he is. Oscar, 3rd, is a navy seaman assigned to the *America;* Tom is a sophomore at M.S.U. (Bozeman); Robert is a marine private in San Diego; and Jim is a junior in high school.

Don't forget there are only two more years to give to the Class of '49 25th

Anniversary Gift. Give early and often. Best wishes to all.—**Frank T. Hulswit,** Secretary, 77 Temple Rd., Concord, Mass. 01742

51

Concern for the environment is "in" and, as one would expect, '51ers are making their impact on it. **J. H. Healy,** with the National Center for Earthquake Research, Menlo Park, Calif., has been studying the possibility that the force of earthquakes might be mitigated by adjusting fluid pressures in fault areas. . . . Another member of the Class, **Mason M. Phelps,** has established a wildlife sanctuary. Mason and his wife, Ina, starting in 1961, gradually acquired some 1,000 acres of natural land about 30 miles northwest of Worcester. The area is called Whetstone Wood. Mason has been with MITRE since it was formed in 1959; is currently a member of the technical staff at Bedford Operations.

Aerospace business may be off, but it's not dead. **Lawrence H. McNeill** is director of Systems and Engineering for Kaman Aerospace Corp. at Simsbury, Conn. . . . Grumman's F14 variable swept wing fighter has had the services of **Donald F. Reis,** Tarrytown, N.Y. He has been support system engineer for the air data computer and for air inlet control. . . . **John H. Morgenthaler** has been director of advanced technology research for Bell Aerospace Co. (Textron) since 1967. John, wife Kay, and three children live in Lewiston, N.Y. His special technical interest is "high speed mixing and combustion computer modeling and experimental validation." . . . Working on the space shuttle project for Martin Marietta is **Edward J. Lays** of Denver. With Martin since 1956, Ed has ratings as a commercial pilot and certified flight instructor. He recently flew his own Piper Comanche to Mexico.

The problems of earthbound transportation are also receiving their share of attention from our classmates. **William R. Miller,** Erie, Pa., is engineering manager for General Electric's Propulsion Equipment Products Department whose products include rotating machinery for G.E.'s locomotives, transit cars and electric truck transmissions. Bill started with G.E. on the co-op program and has been there ever since. He's on the Board of Incorporators, St. Vincent's Hospital; Industrial Chairman of the United Arts Fund; Church Program Committee Chairman; and is building his own electric car (slowly, he says). . . . **M. G.** (Jack) **Wingard** is owner of T. A. Pearson Associates, Inc., general contractors, building bank buildings, factories and telephone buildings. Home for Jack, wife Patricia, and four offspring is Longmeadow, Mass. Jack serves as building trade employers' labor policy chairman, and as a fellow contractor I know what that means.

William H. Ramsey has been named to the Newton (Mass.) Community Relations Commission. During working hours he is program manager for AN/TPQ-34 Radar for Sanders Associates, Bedford. . . . Methodist Hospital of Brooklyn, N.Y., has elected **Bernard Rothzeid** to its Board of Managers. Bernard is founder and head of his own planning and architectural firm and specializes in the design of health facilities. He is a member of the Park Slope Health Planning Council, performs professional services for the New York City Health and Hospitals Corp., and is involved in planning work for model cities in Brownsville, East N.Y., and South Bronx. . . . **Marvin L. Baker** has been transferred back to Houston after 12 years in California. He is manager of Shell Chemicals catalyst business. . . . Also in the petro-chemical field is **James O. Salveson** who has been transferred to the San Francisco office of Chevron Overseas Petroleum Corp. (overseas exploration subsidiary of California Standard) as senior staff geologist.

Martin H. Miller started a new business: RPM, Inc. a manufacturer of young men's jeans and knit slacks. . . . Corning Glass Works has named **Norman M. Edelson** technical manager for special development in the Process Technology Department. Norm has been with Corning since 1955 and other recent positions have included manager of development for capacitors and networks; manager of microcircuits development; and manager of the Data Systems Department for Electronic Products.

Nuclear reactors department. **Alvin Boltax** is manager of Fuel Materials Technology of the Westinghouse Advanced Reactor Division, south of Pittsburgh. "One of our major problems is the void swelling of stainless steels exposed to high doses of fast neutrons. Once again, Shakespeare was right—'much ado about nothing'."

Don't forget, friends, only four more years until the 25th reunion.—**Fred W. Weitz,** Secretary, 4800 S.W. 74th St., Des Moines, Iowa 50321; **Marshall Alper,** Assistant Secretary, 1130 Coronet Ave., Pasadena, Calif. 91107; **John Dowds,** 1800 N.W. 18th Oklahoma City, Okla. 73106; **Samuel Rubinovitz,** Assistant Secretary, 3 Bowser Rd., Lexington, Mass. 02173

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George Hegeman, our chairman for next year's 20th Reunion, will have completed his pilgrimage to Bermuda by the time these notes reach you. George and his wife, Ruth, plan to check out the facilities of the various hotels during the Bermuda trip. We will report the results of George's findings in the next issue of the *Review.* Also, we are looking into travel options between Boston/New York City and Bermuda and will pass along this information to you. A special reunion mailing will be sent at the end of the summer. For those of you who are experienced Bermuda travellers, we welcome any suggestion, both as to accommodation or travel tips. George Hegeman can be reached through me or by writing or calling him at Arthur D. Little, Inc., 35 Acorn Park, Cambridge, Mass. 02140. Phone (617) 864-5770.

News from classmates has been almost as sparse as the Class Notes. You may be interested in hearing that M.I.T. faculty ranked high in the receipt of recent Guggenheim Fellowship awards even though the awards are focussed principally on the arts and humanities. One of our classmates, **Elliott Lieb,** received a Fellowship to carry out work in applied mathematics related to statistical mechanics. . . **Paul Shepherd** has recently been named Corporate Senior Vice President, in charge of engineering, for Cabot, Cabot and Forbes, one of the nation's oldest and largest developers of industrial parks. Paul will continue to be headquartered in San Francisco, at the office which he established for C.C. and F., several years ago. I'm sure the Class wishes to join me in extending congratulations to Elliott Lieb and to Paul for their superior efforts.—**M. C. Manderson,** Secretary, Longley Rd., Groton, Mass. 01450

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Now that your column is appearing regularly (two for two so far) we would welcome a note from all interested classmates during the summer hiatus so that we can maintain the momentum in the fall.

Valfrid Palmer was elected vice president and secretary of New York News Inc. He is married to the former Evelyn Frances McDonagh and has four children: Glenn Edward, Valfrid Joseph, Karen Mary, and Mary Evelyn. Besides being active in the Pelham Country Club and a member of the Winged Foot Golf Club, Valfrid has served on the Pelham Manor Zoning Appeals Board for the past three years. . . . **Gordon Aitken** has been promoted to the position of plant manager of the International Salt Company's Watkin's Glen, N.Y. Refinery. He resides in Watkin's Glen with wife Audrey and daughters, Patience Ann and Audrey Hope. . . . We received a note from **Harry Taylor** through the *Technology Review* office. Harry married Varda Burger in Tel Aviv in March. With his teaching duties at the Technion and Tel Aviv University and waiting consulting clients, the newlyweds could take only five days in Eilat and Sinai for a honeymoon. Harry sends regards to his classmates and hopes to see some of them in Israel. For you travelers, the Taylors reside in Riman, Kiriat Ono.

Will wonders never cease? I recently received a call from **George Schwenk** who was concerned about the recent lack of "54 in print" and who offered to help put this column together. True to his word, George gathered the following with a promise of more for the fall: Marilyn and **Russell Barnes** and their two daughters, Leslie and Lauren continue to brave the football mania of Columbus, Ohio. Russ has been employed by Battelle Memorial Institute since leaving M.I.T. (is this a class employment record?) and expects to finish his Ph.D. in physics at Ohio State. . . . **Fred Schmitt** hangs his hat in Berkeley, Calif., these days. Other than announcing his marriage about three years ago, his Christmas cards have been quite sparse of details. (Are you listening, Fred?). . . . The North Shore ecology community now includes the new Chairman of the Conservation Comm. for the Town of Peabody, none other than **Stan Hoff.** Stan is also active as Marksmanship Coordinator for the 94th Army Reserve Command, including all of New England. He has just returned from leading his rifle and pistol teams in the First U.S. Army Matches at Fort Meade, Md. Stan's wife Flo, not content with their own tribe of five, is becoming a recognized authority on natural childbirth.

Wally Boquist is hard at work as President of Technology International Corporation in Bedford, Mass. A rarity in the government contracting business, T.I.C. is doing relatively well in these rough times. . . . Speaking of trying times, **Dick Morley** and **George Schwenk** found the 1971 business climate no longer viable for contract commercial development. As a result, they suspended development operations at Bedford Associates, Inc. and continues the company as an investment company. Both have been active as consultants but Dick is now forming REMTEC, a company aimed at the industrial peripherals market.

Any more volunteers out there? Best wishes for the summer. Drop a line if you can. If you are cruising in Gloucester waters, keep a lookout for my little blue sloop TANTIVY, hail us and say hello.—**E. David Howes, Jr.,** Box 66, Carlisle, Mass. 01741 or **Charles Masison,** 76 Spellman Rd., Westwood, Mass. 02090

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John C. Lindenlaub has been promoted to Professor of Electrical Engineering at Purdue University. He is a staff member on the West Lafayette campus. . . . **Daniel M. Braddock, Jr.,** has been promoted to senior programmer and manager of systems simulation at the Poughkeepsie laboratory of I.B.M.'s Systems Development Division. He is now responsible for technical coordination between the standards and systems evaluation area and other I.B.M. simulation development groups. Dan joined I.B.M. in 1963 after graduate work at Texas Christian University. He, his wife Joanne, and their five children live in Poughkeepsie.

Lyle F. Warnock found the past year to be a great one; he moved from Lear Siegler to Kent Research and Management Co., as a vice president and director. This follows an M.B.A. from Western Michigan University in finance, during which he developed an extensive computer-aided approach for securities selection and portfolio management. He is also an officer and director of Plumb Investment Associates, a registered investment advisor. . . . On Leap Year Day, 1972, Katherine Wilhelmina McCanless was born. She is the first child of Christel and **George F. McCanless.** Congratulations and best wishes.—**Allan C. Schell,** Secretary, 19 Wedgemere Ave., Winchester, Mass. 01890

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Bill Dickson has been appointed to the advisory committee on shareholder responsibility for the M.I.T. Corporation. . . . **Edmund Pease** is a senior investment officer and personal trust investment group manager at Chase Manhattan Bank. Ed did squeeze in a five-week trip to Europe and the Orient after Christmas. . . . **Wendyl Reis** has been named director of corporate planning of A.C.F. Industries and has returned to work in New York City for the first time since graduation. **Ed Zoolalian** is still manager of manufacturing of Neff Instrument Corp., in California. He and Denise report that the three children are great fun. By the way, he intends to travel East this August. . . . Dr. **Steve Newman** is specializing in urology, or, as he puts it, applied fluid dynamics. With wife Pam and the three boys he also sails a lot.

We must sadly report the death of our classmate **Asghar Ali** of Lahore, Pakistan, on April 8, 1972. If anyone has details, please fill us in.—Cosecretaries: **Bruce B. Bredehoft,** 3 Knollwood Dr., Dover, Mass. 02030; **Mrs. Lloyd Gilson,** 35 Partridge Rd., Lexington, Mass. 02173

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Our 15th Reunion will be at the Harborside Inn at Edgartown on Martha's Vineyard and **Gary Fallick** and the committee have big plans for that weekend. Gary is seeking able-bodied candidates as regional chairmen and, at this writing, good franchises may still be available in your area. Write Gary at 4 Diehl Road Lexington, Mass. Enthusiastic reports about the Harborside Inn have come from all the classes that have been there. The boat ride from Woods Hole makes it a real "escape weekend", so plan now to be there next June.

This spring, many of you have talked with other '58 classmates during the telethons for the Alumni Fund. In talking with **Jeff Ingram** recently, I learned that our class has talked with more class members and received more pledges than any other class during the telethons this year. So, congratulations to everyone that participated.

Among the Sloan Fellows entering this fall will be **Chuck Vicary,** who has been executive vice president and treasurer of the Ervite Corp. in Erie, Pa. . . . Other university notes include **Bright Lowry** who is teaching at S.M.U. in the chemistry department. . . . Also **Jim Mulholland** has received a Ph.D. in the history of technology at the University of Delaware. This is a relatively new field and Jim represents one of the handful of its practitioners.

During one of the telethons, I talked with **Ed Macho** and found that he has become a Connecticut suburbanite working for American Can in Greenwich. . . . **Ed Krokosky** is at Carnegie Mellon. . . . **Jim Mahaffy** is a regional manager for Chase Metals in the Detroit area. . . . Suzanne and **Donald Grimes** are now living in Lansing, Ill. . . . Diane and **Ken Roy** have been in the local limelight this year as a result of Diane being named as "Mrs. Essex County (Mass.) of 1972." They are both active skiers and also participate in a square-dancing group in Peabody. They have two boys, James, 5, and Matthew, 1. . . . Have an enjoyable summer—see you in the fall. And drop me a note about what you've been up to lately!—**Michael E. Brose,** Secretary, 30 Dartmouth St., Boston, Mass. 02116

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Congratulations: **Allan Anderson** is one hell of an architect. He won the first honor award in the Homes for Better Living competition. He won an award for architectural excellence from *Architectural Record* magazine and his home design was selected as one of 20 to appear in "Record Houses, 1972." He has had work published in the *New York Times,* the *Architectural Record* and the *American Home.* Finally he says that he is a member of the architectural advisory board of the Rye, N.Y. school commit-

tee. Wow. . . . More kudos go to **Martin Weinstein** who was promoted to vice president and assistant general manager of the Turbine Support Division of Chromalloy America Co. Wowzer! . . . **Leonard Coris** is in the Top 50 of the President's Club of the National Life Insurance Co., of Vermont. This entitled him to a "meeting" in Bermuda last March. Whoopie Wowzer!

Returning to the more mundane world **Leon Borstein** writes to say that he has been Assistant District Attorney in Kings County, Brooklyn, N.Y., since last June. . . . **Henri Daniel Schnurmann** writes "just a few lines to put you up to date on my whereabouts. I left I.B.M. Research Division after six years there to rejoin the components division in East Fishkill, N.Y., as an advisory engineer. I am presently building a house in Monsey, N.Y., and plan to be moving there in early Summer. Since the last time I wrote you we had a new addition to our family—our second daughter, Debbie, today a 1½-year-old. I just returned from a trip to Uruguay, S.A., to visit my folks and heard that our classmate Arturo Margues lives there." Thanks for the letter Henri.

Don Straffin says that he is a consulting actuary for the firm of Milliman and Robertson in Pennsylvania but he doesn't say where in Pa. . . . Finally (you people have not been writing me as you should) I got a letter from **Sam Williamson** who said: "I joined the Washington Square Campus of New York University this fall as Associate Professor of Physics and am now setting up a lab for studies in ultralow temperatures. Quite a nice set of facilities since the department moved into a new building this year. We have quickly adapted to the life of the urban dweller since our move last summer from California. I have a book, *Fundamentals of Air Pollution* due to be published by Addison-Wesley later this year. It's an interdisciplinary coverage of the physical aspects of causes, evolution, and affects of pollution."

As usual I am staggered by you people and your accomplishments and wonder if I'll ever be able to appear in this column.—**Andrew Braun,** Secretary, 464 Heath St., Chestnut Hill, Mass. 02167

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Greetings! and Olé! Attending the M.I.T. Fiesta in Mexico in March were **Jack Larks** and his wife, Norma, as well as **Murray-Lasso Marco** and his one and only, Nancy. Next year's registration for this fun Fiesta has already begun, so write now for reservations to M.I.T. Club, Mexico City, Apartado Postal—31 Fracc. La Florida, Edo, De Mexico, Mexico, Attn: Alma G. de Gasio, Executive Secretary.

Some congratulations are in order: M.I.T. Professor **Jeffrey I. Steinfeld** (Chemistry) received a Guggenheim Fellowship to study molecular energy transfer. . . . Captain **Niel K. Weatherbie** received his second award of the Air Force Commendation Medal at Eielson A.F.B., Alaska, for meritorious service as communications-electronics operations chief at Wildwood Air Force Station, Alaska.

A brief "who's who" and "who's where": **Donald Dible** is a general partner for the Entrepreneur Press, Santa Clara, Calif. . . . **Jon Zellers** is now completing his second tour of Vietnam serving as an advisor to the South Vietnamese Marine Corps. Looks like a move to Maryland for Jon and family where he expects duty as an instructor at the U.S. Navy Prep School. . . . **Robert Mayers** is a partner in the New York firm of Mayers and Schiff. This successful architectural firm received the 1971 A.I.A. citation for excellence in residential design and the 1971 "LUMEN Award" from the Society of Illuminating Engineers for outstanding achievements in lighting design. . . . And last, a real "who's where" from **Bill Geoghegan** and family. Bill is doing anthropological research with the Philippine Samal, a Muslim society. When not researching, Bill is teaching anthropology at U.C. Berkeley.

Gordon Mann, who is with American Standard in Peoria, Ill., recently took a business and pleasure trip along with his wife, Gayle, to Australia and Hawaii. On their way back home, they stopped and visited at my house with my family. Unfortunately, I was in Missouri on a business trip, and missed them. Gordon was my roommate at Stanford Business School. It hardly seems possible, but I have been writing these Class Notes for ten years now. It has been fun to follow the whereabouts of the people in our class and to share their many achievements in business and education as well as family progress with all of you. At this point, I look forward to passing the duties of Class Secretary on to someone who will derive as much pleasure from the task as I have.—**Gerald L. Katell,** Secretary, 122 North Maple Dr., Beverly Hills, Calif. 90210

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Alan Rogol writes that he graduated from Duke University with an M.D. and Ph.D. in physiology and is interning at Johns Hopkins Hospital. He also reports a son Ian Michael. . . . **Stephen Miller** is glad to be back in the Boston area after being a lecturer at Georgetown University. He is now a clinical fellow in radiology at Massachusetts General Hospital. . . . **Marshall Flam** is a fellow in hematology at the University of Utah Medical Center. He reports a wife and two little girls.

Old Homes

Bob Johnson has moved into an old brownstone in the East Village and indicates, "the long process of renovation has begun." . . . **Allen Clark** and his wife Jeanne recently purchased a run-down old Georgian Mansion which they are slowly fixing up. His three children, "just love running through the big (mostly empty) rooms."

Barristers

Mark Ordower is practicing law in Chicago with the firm of Ordower and Ordower. He and his wife, Jane, and daughter, Stephanie, are enjoying their new house in Deerfield. . . . **Richard Weiner** is practicing corporate law with Wolf, Block, Schorr and Solis-Cohen in Philadelphia where he is on the Executive Committee of the Young Lawyers Section of the Philadelphia Bar Association.

Overseas

Harold Solomon is a visiting lecturer in the Department of Environmental Sciences, Tel Aviv University. He states, "the bureaucracy is bad, but I came for only a year anyway." . . . **James Hadden** spent a year in India while his wife (Susan Ginsburg, Radcliffe '64) investigated electrification policy in the state of Rajastan. News also is a daughter, Lucy, and his Ph.D. in mechanical engineering from Northwestern.

On Campus

Christina Huk Jansen has completed her Ph.D. in metallurgy. She was elected a member of the M.I.T. Corporation and asks, "Since I'm to represent recent classes, I'd appreciate letters or calls so that I have a better idea of the issues that concern you." She is a scientist at Polaroid in Cambridge and has two children, Rolf and Monilea. . . . **Eric Cosman** writes that he is an Assistant Professor of Physics at M.I.T. . . . **Ron Walter** is a faculty resident at Burton and is teaching a course at Tech, but spending most of his time as a student of health services administration at the Harvard School of Public Health. . . . **Steven Berstein** taught an undergraduate seminar on satellite communication at M.I.T. His wife is expecting their first child. . . . **Aldridge Bousfield** is doing research in algebraic topology while an assistant professor at Brandeis. His wife joined the M.I.T. Staff and works on the Troll project at the Sloan School.—**Martin Schrage,** Secretary, 55 Brackett Place, Marblehead, Mass. 01945

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The Class Hero of the month is **Rick Fisher,** who recently sent a postcard from Indonesia saying that the natives are friendly and the local beer is good. . . . **Tom Arnold** and his wife Carol are the proud parents of their first child, William, born this past January. Tom supervises a group of engineers and programmers at Bell Labs. . . . **Robert Blumberg** has become a general partner of Idanta Partners, a relatively new venture capital investment firm. Bob will be opening their New York office, and invites all classmate entrepreneurs to contact him. . . . **Charles Campbell** is buying a 56-foot trawler which he plans to take through the Panama Canal from its California berth to Washington, D.C. He eventually plans to live and cruise on it throughout the world. . . . **Ron Chorba** has received his Ph.D. in business administration at the University of Arizona and is now an assistant professor in management science at the University of Calgary. . . . **Lawrence Kaldeck** is doing scientific programming at Lincoln Labs, and reports a shortage of parking spaces. . . . **Dick Kline** is a research engineer with Deering-Milliken. He, his wife, and son are all well, but their seven-year-old daughter Kathy was killed in a bicycling accident

Managing a new enterprise in today's economy is no easy subject; as the title of a seminar it drew more than 50 alumni to the M.I.T. campus on March 4 and 5. Among the speakers: Kenneth G. Fettig, S.M.'53, (left) on making marketing plans and George F. Cary, III, '64, on make or buy decisions. (Photo: Sheldon Lowenthal, '74)

on February 20. . . . **John Prather** is a manager of an R.C.A. consumer electronics plant in Bloomington, Ind.

T. Repnau is studying at the Rand Graduate Institute for Policy Studies, an experimental program in applied policy analysis through work on Rand research projects. . . . **Richard Stimets** is working in the area of solid state and laser physics as an assistant professor of physics at Lowell Technical Institute. . . . **Jerry Weiner** owns a consulting firm catering to the aerospace industry, and has recently become a partner in a firm doing engineering consulting to the legal profession. Jerry is still living in Fort Worth, Texas. He reports the untimely death of **Dan Frischmuth** from leukemia, which occurred shortly after diagnosis and after only three months of marriage.

Best wishes to you all for a happy summer. Let me here from you.—**Ron Gilman,** 5209 Peg Lane, Memphis, Tenn. 38117

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Tom Maugh, who recently authored an article in *Chemical and Engineering News* about M.I.T. President Wiesner, sent news that he left *Chemical and Engineering News* at the end of April to join *Science* in Washington, D.C. Tom writes for the magazine's Research News section. . . . **Carl King** is a candidate for the Massachusetts state legislature from the Marblehead-Swampscott area. Carl has a law degree from Pennsylvania and served as law clerk to the Massachusetts Supreme Court. Carl and his wife Carolee have three children and live in Marblehead.

Family Notes

Bary Pollack was married last December to "a wonderful girl—Kimberly—who's also on the National Ski Patrol." Bary's second book, *Compiler Techniques,* was published in April and he'll be receiving his Ph.D. in computer science about the time this issue is published. No plans yet for a job after graduation. . . . **Bill Grosky** reports the birth of a son, Seth Israel, in March. The **Geoff Gills** have a new daughter, Laura McAllister, born March 11, 1972. . . . **Ed Strauss** and his wife Heni were married last August. They are living in Pittsburgh, where Ed attends the University of Pittsburgh Law School. Ed finished his first year there in June; looking forward to summer to enjoy the woods of Western Pennsylvania.

Career News

John Murray left the army in May and has joined the Lawrence Livermore Laboratory at Livermore, Calif. John is working on lasers for controlled thermonuclear fusion. . . . **Jim Bochnowski** was elected a vice president of Donaldson, Lufkin and Jenerette (a New York asset management firm) in December. Jim is currently doing security analysis of technology-related companies. Jim joined Donaldson, Lufkin and Jenerette in 1969 after receiving his M.B.A. from the Harvard Business School. . . . **Charles Frasier,** now a lieutenant in the navy, has joined the Naval Electronic Systems Command in Washington. His previous assignment was with the U.S.S. *Independence* with the Sixth Fleet in the Mediterranean. Charles and his wife Francine have a daughter, Wendy, age one year. . . . **Joel Spencer** has been promoted from research associate to assistant professor in M.I.T.'s Department of Mathematics.

Final Notes

Jim Pepe sent word of a postcard from **Joel Greenwald.** Joel is reported to be alive and well in California. Jim also sends word of **Woody Vandever** who has recently joined the Boston Micological Society (I believe, for the care, feeding, and eating of mushrooms.) Woody has a paper at a conference on fault-tolerant computing, and is spending his spare time studying Tibetan grammar.

That is this month's short column. With Alumni Day and the 1973 Alumni Fund, maybe there will be more news in the next one.—**Steve Lipner,** Secretary, 3703 Stearns Hill Rd., Waltham, Mass. 02154

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All, yes all, of the news for this issue is from members of our class who are finishing up various degree programs! **Martin Kaliski** received his Ph.D. in electrical engineering and is now an Assistant Professor of Computer Science at City College of New York. . . . **Peter Catto** completed his Ph.D. at Yale this past year and joined the Institute for Advanced Study in Princeton. . . . **Robert O'Donnell** received his Ph.D. in electrical engineering from University of Texas last August and is presently working for the U.S. Army at White Sands Missile Range.

Matt Fichtenbaum writes "by the time this is printed, Judy and I will have returned from three weeks in Western Europe. This trip represents an acknowledgement of Judy's graduation from Boston University in child psychiatric nursing and the precedence of the better things of life over the pressures of my work." . . . **Gerry Lichtenberger** finished his Ph.D. at Yale this past June. He is now working as a consultant at I.B.M. Research in Yorktown Heights, N.Y. He is "still unmarried and enjoying the freedom." . . . **Bill Tippett** is finishing his M.B.A. at Harvard this June.

Lastly, I received an unsigned letter reporting that the author was "graduating from U.C.S.F. Medical School in June and will be a resident in Ob-Gyn at the University of Hawaii Hospitals in Honolulu for the next three years." Does this sound like someone you know? . . . See you in September!—**Tom Jones,** Secretary, 33 Commercial Wharf, Apt. 35, Boston, Mass. 02110

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The Poughkeepsie Newyorker Barbershop Chorus of S.P.E.B.S.Q.S.A. recently won their divisional competition and qualified to compete on the district level in Montreal in the fall. **Alan Calavano** is the administrative vice-president of the Newyorkers. . . . In June, 1971, **Joseph Franz** received a Ph.D. in materials science from M.I.T. His family of six lives near Burlington, Vt., where Joe works for I.B.M. They enjoy the clean environment and hope that it can be preserved

for everyone. . . . **Harold** and **Carlyn Voss Iuzzolino** expect to receive master's degrees in applied mathematics from University of New Mexico this December. Harold will finish his four years air force active duty in October. Carlyn has been working as a systems programmer at Sandia in Albuquerque. Their daughter Theresa was born February 27, 1971. **Alan Gevins** writes: "I am designing real-time systems for brain-wave analysis at the Langley Porter Neuropsychiatric Institute in San Francisco, and it's a gas gas gas! The name of our new company is Advanced Digital Intelligence. Best regards. End the war." . . . **Melvin Snyder** graduated from Tufts Medical School in June, 1971, and interned at Tufts-New England Medical Center. He has just begun a neurosurgical residency at U.C.L.A. . . . **Stuart Orkin** graduated from Harvard Medical School and is interning at Children's Hospital in Boston. . . . **William Thilly** has been promoted to assistant professor of food toxicology in the Department of Nutrition and Food Science at M.I.T. . . . **Joel Spencer** has been promoted to assistant professor of applied mathematics in the Department of Mathematics at M.I.T. . . . **James Williams,** an assistant professor in M.I.T.'s Department of Mechanical Engineering, has been awarded both a 1972 duPont Young Faculty Grant and a 1972 Research Initiation Grant from the National Science Foundation.—**Jim Swanson,** 508 Thompson Ave., Mountain View, Calif. 94040

Samuel A. Cohen, '68, a teaching assistant in the M.I.T. Physics Department, was presented the Goodwin Medal for conspicuously effective teaching. Irwin W. Sizer, Dean of the Graduate School, made the presentation at the President's Luncheon following Commencement, citing Mr. Cohen's valuable service to the Department and reporting some of the endorsements received from faculty, students and co-workers. Besides teaching and working closely with the students, Mr. Cohen has been the Physics Department coordinator for the Undergraduate Research Opportunities Program, and has placed 120 students on research projects, with regard for their talents, interests and the professor with whom they carry out their work.

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Mail is sort of thin now as it is the end of the year. So here is what we have. I'm sure that by September our mail box will be overflowing again. Hope everyone is having a nice summer. . . . **John Seesholtz** is commanding officer of the U.S.S. *Dolphin,* an experimental, deep diving submarine. During the past year he has been involved with research work at sea in the East Pacific and Alaska areas. . . . **Howard Evans** reports that he is still plugging along in the Air Force. He is now serving in Europe and is enjoying the travel. . . . From the U.S.A.F. Home Town News Center comes word that Sgt. **Ron Suffers** has been named outstanding airman in his unit at Kirtland A.F.B., N.M. He is serving as an engineering assistant with the Air Force Systems Command. . . . Military service does not last forever. There is always light at the end of the tunnel as we are reminded by the example of **Joseph Olsen.** After serving 3½ years in the Army Corps of Engineers he has returned to the old 'tute to do graduate work.

Chris Davis graduated from George Washington School of Medicine and intends to remain there as an intern. . . . **Don Batchelor** is busy working away in grad school at the University of Washington. He had an article published in the February *IEEE Proceedings.* Don reports spending much of his spare time studying, but is also enjoying some opportunities to judge local science fairs through the M.I.T. Club of Washington. . . . From New Brunswick, N.J., **Garvin Clowe** writes that he received an M.S. in computer science in 1971 from Rutgers where he is now in a Ph.D. program. He is also employed part time as a research assistant in the computer science department. . . . **Paul Richter** received a law degree in June 1971 and is now practicing law in Washington, D.C. while studying towards a master's degree in corporate tax law at George Washington University Law School. His wife, Gerry, was recently elected president of the student council at Georgetown University School of Medicine where she is a third-year student.—**Gail** and **Mike Marcus,** 2207 Reddfield Dr., Falls Church, Va. 22043

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At the end of April, I made my way down the Charles River to my old M.I.T. residence for my seventh Senior House steer roast. It was a beautiful sunny day with a number of Senior House alumni in attendance. The V.I.P. list included Chairman Johnson, President Wiesner, Deans Holden and Browning, and Professors Edgerton and Lettvin. Those old residents of Senior House who attended the feast included former presidents Gary Schwartz, '67, **Ivan Burns,** '69, Bob Lada, '70, and Paul Greenfeld, '71. Another former president Mike Krashinsky, '68, was reportedly somewhere in New Haven working on his doctoral dissertation in economics at Yale University. Other alumni included Bob Dann, '67, and his wife Mady; John Hrones, '68; Jerry Sabath, '68; Lenny Goodman, '68, and his wife Mindy; **Dick Hodgman,** '69; Dave Leighty, '70; and Dick Park, '71. The most distant travelers were Bruce Smith, '71, and his wife Ellen who flew in from San Francisco for the weekend of festivities.

The mail bag for this issue was nearly empty so take out some time and drop me a line at your earliest convenience. . . . **John B. Black,** a first lieutenant in the army, reports he is attempting to apply Professor Jay Forrester's industrial dynamics to design a mathematical model of the Sacramento army depot. Although he never took a statistics course, he finds himself continually called on to do regression studies. In the meanwhile, Sacramento State College is providing John with the facilities to pursue his interest in mathematical psychology. . . . **Donald Rosenfield** and the former Nancy Liebman, '71, were married on June 17, 1971. They have moved to Palo Alto, Calif., where Don is studying for his Ph.D. in operations research at Stanford University and Nancy is working for Systems Control, Inc., as a programmer.

Michael A. Talalay graduated from York University, Toronto, in 1971 with an M.A. in political science. He then spent six months wandering around Europe before beginning his work towards a Ph.D. in international relations at the University College in London. . . . **Gary C. Dixon** is still at M.I.T., now working for the Programming Development Office-Information Processing Services, trying to keep Multics running. . . . After having worked as an aerospace engineer at McDonald Douglas in Southern California for two

years, **Steve Hill** is now enrolled as a law student at Case Western Reserve University in Cleveland. Steve expects to receive his J.D. in 1974. . . . **Andrew S. Breiter** is currently working as an independent consultant for some of the most important companies in Italy. . . . **Charles M. Salter** has completed his fourth year with Bolt Beranek as a senior consultant in architectural acoustics and noise control. He expected to complete his M.B.A. program at Boston College this July where he was a part-time student majoring in finance.—**Richard J. Moen,** c/o *Technology Review,* Room E19-430, Cambridge, Mass. 02139

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We have been fortunate to have just enough correspondence to write another segment of the column.

Carl Yankowski has written that **Steve Milligan** (former co-captain of the sailing team) is marrying Carol Sugden, Wellesley, in August. They both are planning to do graduate work in oceanography at the University of Rhode Island. . . . **W. W. Behrens, 3rd,** who is presently doing graduate work at the Sloan School, is achieving fame as a co-author of *Limits of Growth,* the book about the future of the earth and basis for many other articles.

Bill Kindel writes that he picked up a master's degree in computer science at Ohio State, and a wife. He is now an Air Force second lieutenant working as a systems analyst at Offatt A.F.B., Neb. . . . The Aerospace Corp. in El Segundo, Calif., has William Wilson studying radiation from interstellar molecules via millimeter wavelength radio astronomy.

Robert H. Schmidt has kept himself very busy. After graduation he went to Switzerland with the M.I.T. Jazz Ensemble and then served active duty with the National Guard for five months. Although his plans include graduate school and marriage, he is presently employed as a systems analyst with Westinghouse.

After graduating from M.I.T., **Timothy Gilmore** spent a "very enjoyable summer" in Europe, and then began graduate work in air resources engineering at the University of Washington in Seattle, from which he received an M.S. in engineering. He became the Environmental Protection Agency "State Assignee" to the State of Alaska, and is now "half of the air quality control division of the Alaska Department of Environmental Conservation." He writes, "so far I have found Alaska to be everything it was rumored to be." In May, Tim will be married to Miss Susan Murphy, a recent graduate of the University of Washington School of Communications. Tim and Susan are looking forward to a pleasant summer with frequent outings into the great outdoors.

Pam Whitman was in town during March and the beginning of April, attending Corporation meetings and visiting friends and relatives. In October, Pam and a friend of hers, Del McSorley, flew to England and spent a couple of months touring Europe. They bought a car and drove to Nepal, passing through India just at the time of the India-Pakistan crisis, and having some close calls—one town they had stayed in was bombed the day after they left. They left their car in India and flew to Nepal, where **Steve Barr** is serving in the Peace Corps. In mid-April, Pam returned to Nepal. She hopes, eventually, to be able to visit China.

It was really fine to hear from **Jack Confery.** He has left his computer programs for composing jazz music and has gotten an M.B.A. from the University of Chicago. He concentrated in the areas of production and finance, while working as a computer research assistant. Jack married the former Judy Schwalbach of Northern Illinois University. So far we haven't received any word on how he likes his job as a car product planning analyst in Dearborn, Mich. . . . That's all folks.—**Robert Vegeler,** Class Executive Committee, 511 Beacon St. A-9, Boston, Mass. 02115; **Laura Malin,** Secretary, 406 Beacon St., Apt. 1, Boston, Mass. 02115

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We got a long letter from **Marc Barman.** We censored the letter quite a bit, but still don't want to be held responsible for its contents. We therefore state that the following are quotes and are only hearsay evidence, unadmissable in a court of law. "Fabrications, indeed! At least you got the part about **(Chris) Marler** straight. **(Kerry) Mull** would love to be in Denver, but is working for a consulting firm in Arlington, Va. He alternates time between his computer and his wife, who is far out, by the way. **(Robert) Bendler** (censored information concerning a questionable relationship with Ma Bell) . . . (censored information concerning a questionable relationship with a freshman girl from Los Angeles) . . . and has accepted a full-time job at someplace in Mountain View. He says the Ph.D. market is too saturated, so is taking his M.S. with joy, etc. **Dan Griffin** is living in a (censored) at Berkeley. 'Nuff said. (Julian) Krolik, '70, is there too. **Ed**-the Hick-**Salzberg** is working for the Post Office in Palo Alto, and has a lot more fun than anybody. **(Richard) Ziebelman** is out there studying anthropology and will be in Mexico this summer.

"I **(Marc Barman)** am in the Business School of all things (along with **Jack Hiatt**). I spend all my time with the Stanford Band (remember the Rose Bowl) and bicycling to the beach. This is the deadest campus I've ever seen in my life. I'll be in Chicago this summer if that turns anybody on, I'll be there if it doesn't. (A little more censored stuff)". We thank you, Marc, for the letter and all the printable information.

On the front page of the *San Francisco Chronicle* on March 22, 1972, there was an article entitled "A Big Dollar Giveaway." "A young graduate school dropout with a fundamentalist fervor set off a wild scrimmage in Berkeley yesterday by handing out dollar bills from a shoe-box. **Romek Figa,** 22, passed out at least $500 in $1 bills as hordes of students scrambled for the cash near the University of California. 'I studied economics here and they taught me that accumulating money is an important thing. This is an idolatrous lie.' Figa shouted. Standing by a hand-lettered sign that said 'Green Leaves for the Needy' and holding his shoebox, Figa's offer of money at first was greeted with cool skepticism. That didn't last long though. 'This is real!' one student exclaimed. . . . Figa said he first studied physics 'to try and unlock the secrets of the universe,' later taking up economics (at M.I.T.) in hope of being 'able to make a better country.' At length, Figa said, he turned to religion and found 'that the true answer comes from Christ. The more I talked to Christ, the more I found his living spirit would protect me.' . . . 'All of you are idolators,' Figa cried in an evangelical fury. . . . When the box was empty Figa saw it as a metaphor. 'Look into the empty box,' he told the crowd,' and all you will find is emptiness in money.' 'Those who follow god, follow me.' Figa began walking onto the campus toward Sproul Hall. No one followed."

L. Scott Ramos wrote to say that he was married last June to Joan Manaster, a 1972 anthropology graduate of B. U. He is now attending Washington State University, where they are actively promoting their reputation as "eco-freaks", being involved in Sierra Club, Zero Population Growth, and Pullman Recycling Center. In addition, he is a co-director of W.S.U. Earth week. If that isn't enough, he's working on an M.S. in environmental science.

Fritz Stawitcke wrote to tell us that he's getting an M.S. in mechanical engineering from Stanford University, June 1972. He plans to go to work in the Los Angeles area while his wife (Christine) works for a B.A. in art at Pomona College in Claremont, Calif.

Roy Whiddon is living in Allston and doing computer programming for Professor Shapiro, of the Mechanical Engineering Department. He will probably be moving to Berkeley, Calif., this summer to seek his fortune. . . . **Bruce Rummel** is working in Cambridge this summer and in September is going to the University of Washington for graduate work. . . . **Ken Weisel** is still living in the wilds of Central Square and looking for a job.

We finally graduated this June. At graduation we also saw **Steve Ehrmann, Leslie Lynn, Jeff Lynn, Al Solish, John Newkirk,** and **Stu Schwartz.** I'm sure there were a lot more '71ers finally graduating this past June, but these were the ones we happened to see in line.

Please write to us and tell us what you and the classmates in your area are up to. Peace and happiness.—**Howard Jay Siegel,** President; **Leah H. Jamieson,** Executive Committee Member, 26 Peverell St., Apartments 1 and 2, respectively, Dorchester, Mass. 02125

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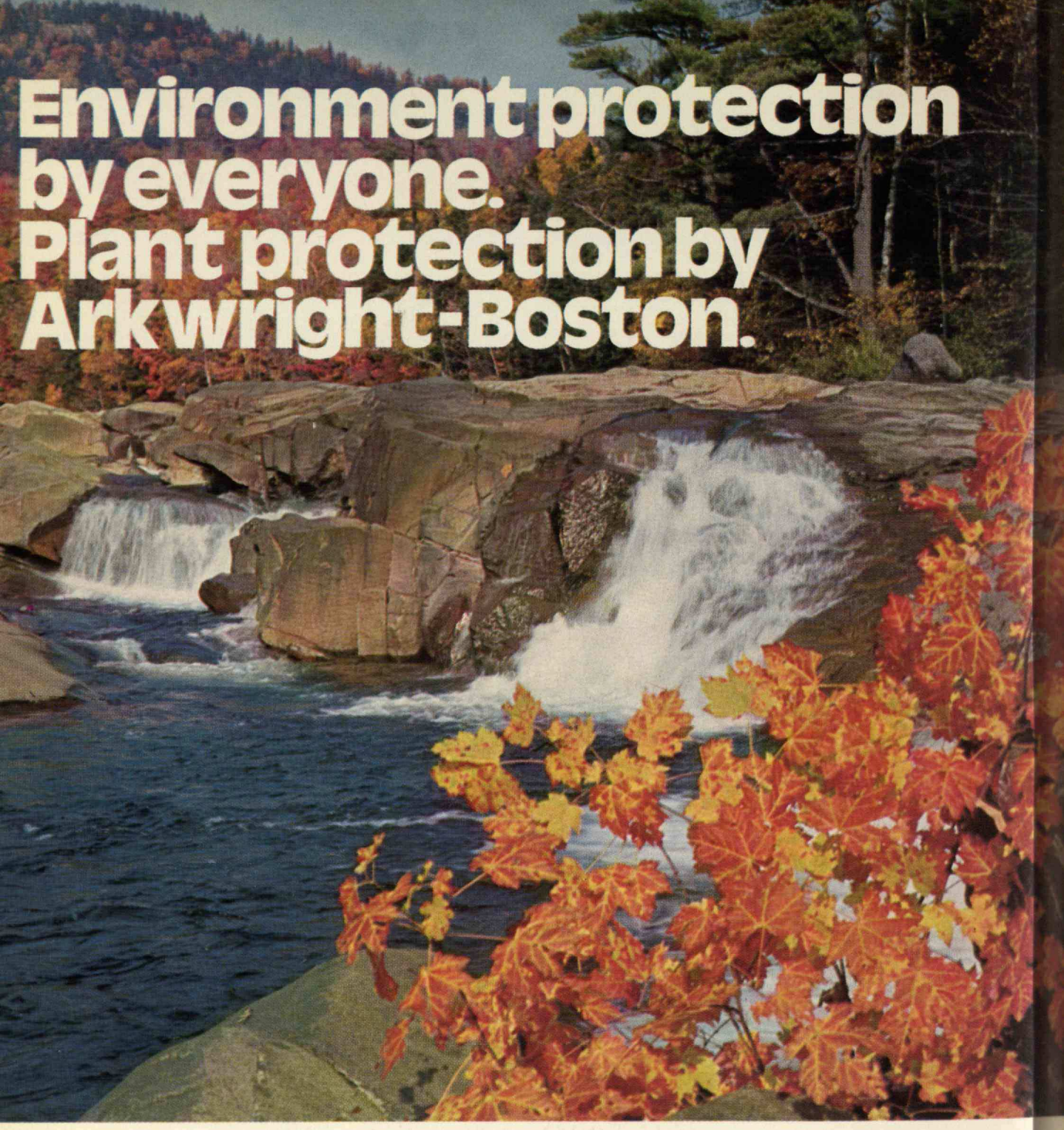

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